97

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OFFICE OF EXPERIMENT STATIONS

BULLETIN No. 15

HANDBOOK

OF

EXPERIMENT STATION WORK

A POPULAR DIGEST

OF

THE PUBLICATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES

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PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

The Office of Experiment Stations issues two classes of publications for general distribution:

(1) Experiment Station Record, Experiment Station Bulletins, and Miscellaneous Bulletins, which are more or less technical. It is the practice to send to persons applying for them one or more numbers, from which they may judge of their usefulness, but not to place any names upon the mailing list until after receipt of applications on special blanks furnished by the Office.

(2) Farmers' Bulletins, which are brief and popular in character, and are sent on application. These bulletins are issued as part of the general series of Farmers' Bulletins of the Department of Agriculture.

The following publications have been issued:

Experiment Station Record, vol. I, 6 numbers; vol. II, 12 numbers; vol. III, 12 numbers and index; vol. IV, Nos. 1–10. Copies of the station and Department publications abstracted in the Record can, in many instances, be obtained on application.

Experiment Station Bulletins.—No. 1, Organization and History of the Stations; No. 2, Digest of Annual Reports of the Stations for 1888, in two parts; No. 3, Report of Meeting of Horticulturists at Columbus, Ohio, June, 1889; No. 4, List of Station Horticulturists and Outline of their Work; No. 5, Organization Lists of Stations and Colleges, March, 1890; No. 6, List of Station Botanists and Outline of their Work; No. 7, Proceedings of the Fifth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, Washington, D. C., August, 1891; No. 8, Lectures on Investigations at Rothamsted Experimental Station; No. 9, The Fermentations of Milk; No. 10, Meteorological Work for Agricultural Institutions; No. 11, A Compilation of Analyses of American Feeding Stuffs; No. 12, Organization Lists of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States, June, 1892; No. 13, Organization Lists of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States, April, 1893; No. 14, Proceedings of a Convention of the National League for Good Roads.

Miscellaneous Bulletins.—No. 1, Proceedings of Knoxville Convention of Association of Agricultural Colleges and Stations, January, 1889; No. 2, Proceedings of Washington Convention of the Association, November, 1889; No. 3, Proceedings of Champaign Convention of the Association, November, 1890.

Farmers' Bulletins.—No. 1, The What and Why of Agricultural Experiment Stations; No. 2, Illustrations of the Work of the Stations; No. 9, Milk Fermentations and their Relation to Dairying; No. 11, The Rape Plant.

Communications intended for this Office should be addressed to the SECRETARY OF AGRICULTURE, for the *Office of Experiment Stations, Department of Agriculture, Washington, D. C.*

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., March 27, 1893.

SIR: I herewith transmit for publication, as a part of the exhibit of this Office at the World's Columbian Exposition, a bulletin entitled "Handbook of Experiment Station Work: a popular digest of the publications of the agricultural experiment stations in the United States." This is a first attempt to collate in a systematic manner the information published by the experiment stations since their foundation, nearly twenty years ago. The effort has been made to give in brief such information as seemed of interest and importance to the farmer and to refer more or less definitely to the station publications in which this and additional information in similar lines is to be found. While the stations have already done a large amount of original work, they have also published much useful information in compilations. The scope of this publication did not permit reference to original sources, but only to station publications. It must therefore be understood, as regards especially the descriptions of fungi and insects, that many of the articles from which the descriptions are taken are largely compilations.

When the Office undertook this work it had no index of the early work of the stations, and the press of other duties has made it impracticable to complete such an index. The references to this part of the station work are therefore relatively incomplete, and it is more than likely that some important material has been overlooked.

It will be readily understood by those familiar with station work that it is very difficult to make satisfactory summaries of investigations in certain lines. This is perhaps especially true of feeding experiments. To make a thorough digest of the station literature would require far more time and labor than could be devoted to this work. It is hoped, however, that at least the main results of station work have been stated with sufficient fullness to make them intelligible to the reader.

As this is in no sense a manual or encyclopedia of agriculture, many subjects which would properly find a place in a work of that character are omitted, and the treatment of many others is very fragmentary. Most of our stations are at the beginning of their work, and have done

little or nothing in many lines. In some cases it was difficult to decide whether the work done was of sufficient importance to justify a mention of it in this publication. The rule followed was to admit everything which seemed at all likely to prove of benefit to the farmer. For example, a brief note that the station in California has planted a certain kind of tree may not seem to be of much consequence, yet there may be persons interested in the growth of that species who by this reference will be able to get further information by correspondence with the California Station. All the stations have collected many data which they have not published, and they are very willing to supply such information as they have to all inquirers.

It is hoped that one result of the publication of this work will be to bring the stations into closer relations with the public, as well as to diffuse among all the States knowledge of what has been done by all the stations.

The United States Department of Agriculture, through its Office of Experiment Stations, desires to bring the stations and farmers of the whole country into the most intimate relations and is glad to serve as an intermediary in this good work wherever and whenever it can.

The general plan of this publication was suggested by Hon. Edwin Willits, Assistant Secretary of Agriculture, under whose direction the work has been carried on. The labor involved in its preparation has been shared by all the members of the editorial staff of the office. The general editorial supervision has devolved upon Mr. A. C. True, who has also prepared some of the articles on field crops and on the more general topics; Mr. E. W. Allen has prepared the articles on subjects connected with chemistry, animal production, and dairying; Mr. W. H. Beal, those on meteorology, soils, and fertilizers; Mr. Walter H. Evans, those on grasses, seeds, weeds, diseases of plants, and insects; Mr. E. S. Steele, as special agent for World's Fair work, did a large amount of indexing of station publications preparatory to the preparation of articles on the various subjects, and has also prepared the articles on subjects connected with horticulture and forestry; Mr. J. F. Duggar prepared some of the articles on field crops, especially those of the Southern States, and also rendered important assistance in the work on animal nutrition.

Very respectfully,

A. W. HARRIS,
Director.

HON. J. STERLING MORTON,
Secretary of Agriculture.

HANDBOOK OF EXPERIMENT STATION WORK.

ABBREVIATIONS.—In references to station literature the ordinary abbreviations for names of the States are used to designate the stations, except that in those cases where there is more than one station in a State an additional distinguishing word is used, *e. g.*, Tenn. = Tennessee Station; Ala. Canebrake = Alabama Canebrake Station; R. = Annual Report; B. = Bulletin; O. E. S. = Office of Experiment Stations; U. S. D. A. = United States Department of Agriculture. At the end of each article or subdivision of an article is given a list of references not included in the article.

Acacia trees.—Several Australian acacias of the group known as wattles are widely grown along the California coast, and are recommended by the California Station to plant for tan bark and timber (*Cal. R. 1882, p. 102; R. 1885–'86, p. 119; R. 1890, p. 195*). The most important of the acacias for tan bark is the black wattle (*Acacia decurrens*); the golden wattle (*A. pycnantha*) is rather small for profit; *A. dealbata,* frequently planted around San Francisco Bay and known in nurseries as *A. mollissima,* is valuable for fuel, but according to Von Mueller is not sufficiently rich in tannin. The bark of the black wattle, air-dried, contains over 40 per cent of tannin (*Cal. B. 4, B. 22*) while oak yields only 10 or 12 per cent. For timber the blackwood acacia (*A. melanoxylon*) is especially recommended as being an equally fast grower as the black wattle and furnishing "a most valuable timber, which in Australia is used largely for tool handles; in fact it seems to be there a substitute for ash." The black wattle and the silver wattle would furnish valuable fuel where fuel is expensive. Caution is given against the cottony scale (*Icerya purchasi*), which seems especially fond of the acacias.

Acetic acid.—For the effect of acetic acid on churnability of cream see *Churning sweet and sour cream.*

Acid phosphate.—See *Fertilizers* and *Phosphates.*

Actinomycosis [also called Big jaw or Lumpy jaw of cattle; Big head of horses].—A local affection caused by a parasitic fungus, the spores of which find an entrance to the animal through wounds or abrasions of the skin or internal membranes, through the temporary exposure of the tissues in shedding teeth, etc. These fungi generally develop in the jaw, but sometimes in the tongue, lungs, and other parts of the body. Groups of them may be seen with the naked eye as minute yellowish specks in the diseased tissues. Until recently the only remedy has been to remove the diseased growth with the knife or with caustics before it had spread too far (*Ark. R. 1889, p. 107; Ohio B. vol. III, 3*). Experiments in Germany and France and by the Bureau of Animal Industry of this Department have lately shown that actinomycosis may be successfully treated with iodide of potassium. This remedy must be carefully used and should not be given to milch cows as it renders the milk unfit for use.

"In treating actinomycosis in cattle with iodide of potassium the dose should never exceed 1 gram (one-fourth dram) for every hundred pounds live weight, the proper dose being from 8 to 12 grams (2 to 3 drams) according to the size of the animal and the extent of the lesion. This dose may be given from five to six days, when the animal will show slight symptoms of iodism, viz, discharge of thick mucus from the nose and excretion of tears. The manure will become rather dry, but that is easily repaired by giving a dose of glauber salts and some bran mash. This will restore the appetite, and two days after the last dose is given the animal will be

ready for another week's treatment, and so on until a cure is effected. If these precautions are taken, no ill effect will result from the treatment, and if properly fed the animal will gain in condition uninfluenced by the medicine. There is, however, a great difference as to the individual effect of the medicine on animals, but any farmer who takes an interest in seeing his stock doing well will easily perceive when it is time for him to stop and give the animal rest for two or three days.

"The medicine is best administered dissolved in water and given by means of a slender, long-necked bottle, for example, a common Rhine-wine bottle. One dose of medicine is dissolved in a pint of water, the steer is seized by the nose to hold up the head, and the contents of the bottle is emptied into the mouth without fixing or securing the tongue in any way."—(*Bur. An. Industry, B. 2.*)

Adzuki bean.—See *Bean.*

Aërator.—An apparatus designed for deodorizing milk and cooling milk or cream rapidly to prevent fermentation. The practice of cooling and aërating milk is comparatively new, and much importance is attached to it, especially for milk shippers, by several prominent authorities. For a discussion of the bearing of the rapid cooling of milk after milking on its souring, see *Milk fermentations.* The Vermont Station (*B. 27*) found the Evans and Heuling cooler and aërator capable of cooling 100 pounds of milk from a temperature of 82° F. down to 44° with 417 pounds of water at 39°. At the New York Cornell Station (*B. 39*) milk was cooled to 50° F., using about a third more water at 36° F. than milk, at the rate of 550 pounds per hour, or with about three times as much water as milk 300 pounds of milk per hour were cooled to 43°. It was also found that the Champion aërator would keep cool 225 to 250 pounds of milk per hour down to about 60° F. if kept filled with ice. The station prefers the Evans and Heuling cooler where running water is at hand, otherwise it recommends the Champion. The Powell aërator is intended to aërate without cooling. It was found that milk aërated in it kept little if any longer than that not aërated, and that milk treated in the Evans and Heuling and in the Champion coolers kept a few hours longer than milk not aërated or cooled, although the conditions were very favorable for keeping the untreated milk, and it is believed the difference would ordinarily be greater. The Pennsylvania Station (*B. 20*) kept milk cooled in the Evans and Heuling cooler practically sweet for two days in summer.

As to the creaming of aërated milk, tests by the New York Cornell Station (*B. 39*) showed that it creamed nearly or quite as completely in cold, deep setting as untreated milk.

Agricultural experiment stations.—The first regularly organized station in the United States was established at Wesleyan University, Middletown, Conn., in 1875. Some investigations of a character similar to those conducted by the stations had been previously carried on at agricultural colleges. Within a few years similar stations were organized by State or college authority in a number of different States, and in 1887 Congress passed a law providing for the organization of stations in all the States and Territories. Under this act, passed March 2, 1887, $15,000 is annually given from the U. S. Treasury to each State and Territory. With a few exceptions, provided for in the act, these stations must be departments of the land grant colleges. Under this act stations are now in operation in all the States and Territories, except Montana and Alaska. In several States the United States grant is divided so that 50 stations in 47 States and Territories are receiving money from the U. S Treasury. In each of the States of Connecticut, Massachusetts, New Jersey, and New York a separate station is maintained entirely or in part by State funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by sugar planters. In several States branches or substations have been established. If these be excluded the number of stations in the United States is 54. During 1892 the annual revenues of the stations amounted to $997,244, of which $589,512 was appropriated from the National Treasury, the rest coming from State governments, private individuals, fees for analyses of fertilizers, sales of farm

products, and other sources. The stations employ about 500 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work in 1892 was as follows: Directors 68, chemists 115, agriculturists 54, horticulturists 59, botanists 36, entomologists 36, veterinarians 23, meteorologists 14, biologists 9, physicists 3, geologists 4, irrigation engineers 3, in charge of substations 27, secretaries and treasurers 28, librarians 4, clerks 23. There are also 21 persons classified under the head of miscellaneous, including superintendents of gardens, grounds, and buildings; foremen of farms and buildings; apiarists; herdsmen, etc.

During 1892 the stations published 55 annual reports and 250 bulletins. The mailing lists of the stations now aggregate some 400,000 names. The results and processes of experiments are also described in thousands of newspapers and other periodicals. The stations are represented in the U. S. Department of Agriculture by the Office of Experiment Stations, an account of which is given on p. 233. Brief accounts of individual stations are given under the names of the several States and Territories.

Agricultural schools and colleges.—The institutions for agricultural education in the United States may be classified as follows: (1) Institutions in which the sciences related to agriculture are taught; (2) colleges in which these sciences are taught along with the theory and practice of agriculture; (3) schools in which the elements of agriculture and other sciences are taught in connection with the practice of agriculture. In addition to regular courses of from two to four years duration many institutions give short farmers' courses during the winter months. The Pennsylvania State College has recently undertaken to supervise a course of home readings for farmers. The number of schools and colleges in which there are courses in agriculture is now 66. These employ in all their departments not far from 1,200 professors and other teachers. The whole number of students is about 12,000, of which some 3,500 are in the courses in agriculture. Most of these institutions are organized as departments of the colleges deriving a share of their endowment from the proceeds of the sale of public lands granted to the several States for this purpose under the act of Congress of July 2, 1862. Liberal appropriations are annually made by many of the States for their support. By the act of Congress of August 30, 1890, grants of money from the U. S. Treasury were made for the maintenance and endowment of the land grant colleges. Fifteen thousand dollars was appropriated to each institution for the year ending June 30, 1890, and the act provides for an annual increase of $1,000 in succeeding appropriations for ten years, after which time the annual amount to be paid to each State or Territory is to be $25,000. These funds can be applied only to instruction in agriculture and mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their application in the industries of life and to the facilities for such instruction. Provision must be made for colored as well as white students and in case separate institutions are maintained for the two races the division of funds must be an equitable one. Reports must be made annually to the Secretaries of Agriculture and the Interior.

Agriculture.—As denoting a department of station work the term agriculture is variously applied. Strictly speaking it is used to include investigations on field crops, but it is often applied also to those in horticulture, animal production, and dairying. Unless otherwise specified the term is technically used in this work in its restricted sense, when referring to station work. An officer called an agriculturist is employed at 38 of the stations.

Alabama Canebrake Station, Uniontown.—Organized in 1885 under State authority and now supported by State funds. The station staff consists of a director, assistant director in charge, veterinarian, and treasurer. The director of the Alabama College Station is *ex officio* director of this station. The work of this station consists principally of field experiments with different crops. Up to January 1, 1893, it had published 3 annual reports and 15 bulletins. Revenue in 1892, $3,500.

Alabama College Station, Auburn.—Organized in June, 1883, under State authority, and reorganized under act of Congress April 1, 1888, as a department of the Agricultural and Mechanical College of Alabama. The staff consists of the president of the college and the board of direction, chemist, botanist and meteorologist, agriculturist, biologist, veterinarian, assistant agriculturist, four assistant chemists, and assistant botanist and clerk. Its principal lines of work are meteorology, analysis and control of fertilizers, botany, mycology, and field experiments with crops and fertilizers. Up to January 1, 1893, it had published 4 annual reports and 41 bulletins. Revenue in 1892, $23,340.

Albuminoids in feeding stuffs.—See *Feeding farm animals.*

Alfalfa (*Medicago sativa*) [also called Lucern].—A perennial forage plant, resembling clover in its feeding value, habits of growth, and effects on succeeding crops. Under favorable conditions it will live from eight to fifteen years and does not run out as clover does. It has long been cultivated in Europe and is grown quite extensively in California and some of the other Western and Southern States. It seems probable that it may be introduced with advantage into many parts of the Southern States east of the Mississippi, and over a wide tract of the more arid regions of the Southwest. It has been grown successfully for several years at the station at Geneva, N. Y., but in recent experiments on thirty farms in different parts of Vermont it was very largely winterkilled (*Vt. R. 1888, p. 81*). While a Southern climate is more favorable to alfalfa, numerous experiments have shown that it will do well in many localities in the Northern States, and when established will produce from three to five crops each season for a number of successive years. "Alfalfa is especially adapted to dry climates and withstands drought much better than ordinary clovers." For this reason it is largely relied on in Colorado and California, especially where irrigation is used.

Alfalfa is one of the plants which collects nitrogen from the air (see *Leguminous plants*). It also gathers a considerable amount of phosphoric acid and potash. At the New Jersey Station in two years the alfalfa grown on 1 acre collected 553 pounds of nitrogen, 98 pounds of phosphoric acid, and 586 pounds of potash, valued at $124.

If alfalfa and its products are properly utilized on the farm it can not be considered an exhaustive crop, but rather one which transforms the raw materials in soil and atmosphere into products for man's use (*N. J. R. 1888, p. 105; Conn. Storrs B. 5.*)

Composition.—See *Appendix, Tables I and II.*

Culture.—Alfalfa prefers a light, sandy, or loam soil, with a subsoil through which its long roots can penetrate. In some cases its taproot goes down 12 to 15 or even 20 feet. At the New York Station, however, alfalfa has been successfully grown on a clay soil (*N. Y. State R. 1888, p. 331, B. 16, n. ser.*). On such a soil greater pains must be taken to secure a good stand, but when the plant is once established the character of the subsoil is of more importance than that of the surface soil (*Minn. R. 1888, p. 179*). Use fresh, pure seed. Sow at any time when the ground is in suitable condition and when there will be time for the plants to become well established before they are subjected either to drought or extreme cold. The soil should be thoroughly prepared and the seed sown at the rate of 15 to 20 pounds to the acre. If sown broadcast about the latter quantity will be required; if in drills the former amount will be sufficient. In the North spring seeding is advisable, but in the South it is better to sow in the fall (*Colo. R. 1890. p. 188; N. J. R. 1888, p. 105, R. 1889, p. 153, R. 1890, p. 156; N. Y. State B. 16, n. ser.*)

In regions where irrigation is necessary the Colorado Station advises that the water should be applied to alfalfa before cutting, because thus the mower does its work more effectively and the growth of the succeeding crop is stimulated. A relatively large amount of moisture is required the first year in order to secure a good stand.

HARVESTING.—Alfalfa should be cut during the first period of good weather after the blossoms begin to appear. If allowed to stand too long its stalk becomes hard and woody and succeeding crops are likely to be diminished. If designed for hay it must be carefully cured and housed, for otherwise its leaves will drop off and only a mass of bare stalks be left (*N. Y. State B. 16 n. ser.*).

AS A FEEDING STUFF.—During a single season alfalfa furnishes a large amount of nutritious green forage relished by all kinds of stock. It should be partially wilted or mixed with hay or straw. In the dry regions of the West it is much used for pasturage, especially in the fall, but there is more or less danger that it will cause the cattle to bloat or that the plants will be killed by close pasturing. Cattle, sheep, and horses relish alfalfa hay and seem to thrive on it.

Chemical analyses and digestion experiments show that alfalfa compares very favorably with red clover both as green fodder and as hay. It may be used either for fattening or for milk. To secure a well-balanced and economical ration, alfalfa, which contains a large proportion of protein, should be fed with corn, wheat, oat straw, root crops, etc., which contain relatively large amounts of the other food ingredients (carbohydrates and fat). In many instances farmers might profitably raise alfalfa as a substitute for the wheat bran, cotton-seed meal, and other materials which contain large amounts of protein and which they are now buying in order to utilize the excess of carbohydrates produced in corn and other crops (*N. J. R. 1888, p. 110*).

DISADVANTAGES OF ALFALFA.—(1) It is not easily established, (2) it is less hardy than clover, (3) if allowed to grow too long its stalks become hard and woody, (4) except in dry regions cattle can not be safely pastured on it, (5) it requires peculiar treatment to make good hay.

ADVANTAGES OF ALFALFA.—(1) When established it does not run out, (2) it withstands drought much better than clover, (3) it grows rapidly and may be cut early in the season, (4) it gathers a large amount of nitrogen from the air as well as from the soil, and is therefore very valuable as a fertilizing crop, (5) it furnishes several large crops of green fodder each season, (6) when properly cured it makes an excellent hay, (7) it is relished and digested by all farm animals and is an excellent flesh and milk producer, (8) it makes muscle rather than fat, and is therefore valuable to use with corn and other fat-producing crops to make a well-balanced ration for cattle.

In brief, experience at the stations and elsewhere indicates that alfalfa is valuable as a feeding stuff and as a fertilizing crop, but that it requires peculiar conditions of climate and soil for growth and careful culture and curing to make it a profitable crop. It is worthy of repeated and systematic experimental tests by farmers, even though in some regions and on some farms it should prove a failure.

(*Ala. Canebrake B. 9; Colo. B. 8, R. 1888, p. 31, R. 1890, p. 188; Conn. Storrs B. 5, R. 1889, p. 29; Del. B. 5, R. 1889, p. 94, R. 1890, p. 79; Ill. B. 15; Iowa B. 11; La. B. 26, B. 8, 2d ser., R. 1890, p. 177, R. 1891, p. 11; Me. R. 1889, p. 166; Mass. State R. 1888, pp. 223, 227, R. 1889, p. 158; Minn. B. 12; Miss. R. 1889, p. 33, R. 1890, p. 31, B. 20; Nebr. B. 17; Nev. R. 1890, p. 15; N. J. R. 1886, p. 168; R. 1887, p. 160, R. 1888, p. 105, R. 1889, p. 153, R. 1890, p. 156; N. Y. State B. 16, n. ser., R. 1889, p. 138; N. C. B. 73; S. Dak. R. 1889, p. 26; Tex. B. 20; Wyo. B. 1.*)

Alfalfa leaf spot (*Pseudopeziza medicaginis*).—This disease is found in nearly every place where alfalfa is grown. Usually it does not attack the plant until the second year's growth, when the plant is able to survive the disease. Sometimes, however, it completely destroys seedling plants. The disease shows itself as minute dark-brown spots of irregular shape upon the green or discolored leaflet. The center of each spot forms a small pustule. In this are developed the spores, which are set free by the breaking of the epidermis. The disease readily survives the winter, and may develop year after year in the same field. In serious cases covering with straw and burning alone stopped the disease. It may be held in check by frequent cuttings. (*Del. R. 1890, p. 79.*)

Alfalfa root rot (*Ozonium auricomum*).—The fungus causing this disease has been identified as the same as that causing the "root rot of cotton" (see p. 96). It attacks the crown of the plant and works down for 6 to 10 inches, completely killing it. In the field the disease spreads in almost a perfect circle, at a rate of 50 or 60 feet during the season, killing every plant. It is thought that sowing salt plentifully or applying kerosene over the infested spots will kill it out, thus preventing further spreading. The disease is worst in dry, hot weather. (*Tex. B. 22.*)

Alkali soils.—A term applied to soils found throughout a wide area in the arid and semi-arid districts of the United States containing an unusual amount of soluble mineral salts which effloresce or bloom out in the form of a white powder or crust in dry weather following rains or irrigation. The basis of these salts is mainly soda, together with smaller amounts of potash and usually a little lime and magnesia. They are mixtures chiefly of sulphate of soda (Glauber's salts), chloride of sodium (common salt), and carbonate of soda (sal soda) in varying proportions. They contain besides smaller amounts of sulphate of potash, phosphate of soda, and nitrate of soda, substances whose fertilizing value is well known. Two distinct classes of alkali are known—white alkali, composed largely of sulphate of soda and common salt, which is comparatively harmless; and black alkali, composed largely of carbonate of soda, which is highly corrosive and destructive to vegetation.

Practically the same alkali salts are found in all soils, but in regions of abundant rainfall the excess is regularly carried off in the drainage water. In regions of deficient rainfall, on the other hand, there is no regular flow of drainage water and the scanty moisture only carries them a little way down into the subsoil, from which they rise to the surface by the evaporation of the water and are thus accumulated at or close to the top of the soil.

Injurious effects of alkali are manifest not only in the corrosive action on the roots of plants and on the vegetable matter of the soil, but also in the case of black alkali in its tendency to render the soil pasty and difficult to till.

"The reclamation of alkali lands for general agriculture rests upon three chief points: (1) Reducing surface evaporation to the lowest possible point; (2) rendering the corrosive salts as bland as possible by the use of chemical antidotes or neutralizers; and (3) correcting their unleached condition by underdrainage, and by flooding, thus supplementing the deficient rainfall."

The first result may be secured to some extent by frequent and deep tillage and by growing such plants as alfalfa, which root deeply and shade the ground. In the many cases where alkali is not very abundant this will temporarily suffice. The second remedy, the use of chemical antidotes, likewise affords temporary relief and is of greatest value only when the proportion of alkali is small and of a corrosive nature (black alkali). In case of neutral alkaline salts (white alkali) they afford no relief. Lime and calcareous marls are valuable as correctives for alkali containing Epsom salts, bittern, chloride of calcium, alum, copperas, etc., but gypsum has been found to be the most generally satisfactory neutralizer of alkali salts. It is especially applicable in case of soils containing black alkali. Corrosive black alkali is by this means converted into the comparatively harmless white form. The alkaline phosphates, which are always present, and the humus are fixed, and the physical condition of the soil is improved.

Irrigation (preferably subirrigation) in connection with underdraining is also employed. The most satisfactory method of procedure would be the application of gypsum to correct the corrosive quality of the alkali and to fix the alkaline phosphates and humus present, and irrigation and drainage to gradually wash out the excess of salts from the soil. (*Cal. R. 1890, App.; Colo. B. 9; Tex. R. 1889, p. 94.*)

Alkekengi.—See *Physalis.*

Almond trees (*Prunus* [*Amygdalus*] *communis*).—These have been planted at several stations. At the California Station, where 10 varieties have been planted, the

trees have done well. The "double white Siberian almond," top-worked on native plum stock, is recommended by the Iowa Station (*B. 16*) as an ornamental small tree. (*Cal. R. 1888-'89, pp. 86, 137, 184, 196; La. B. 22, B. 8, 2d ser.; N. Mex. B. 2, B. 4; R. I. B. 7; Tenn. R. 1888, p. 12.*)

Alsike clover.—See *Clovers.*

American Holderness cows.—See *Cows, tests of dairy breeds.*

Ammonia copper.—See *Fungicides.*

Ammonium sulphate.—See *Fertilizers* and *Nitrogen.*

Anthracnose of bean (*Colletotrichum lindemuthianum*).—A fungous disease which appears upon the pod in deep, dark pits, materially decreasing the yield of salable beans. It will also spread rapidly among green beans in the market. The spores of this disease are carried over from one season to the next in the bean itself. When infected seed is planted the plants are soon affected and either do not grow at all or if they do it is only to spread the infection to otherwise healthy plants. The infected seed may be often distinguished by its shriveled and discolored appearance. Such seeds should be rejected, and only sound plump seeds used. In this way the disease can be greatly restricted. Successful experiments have been made in treating seed before planting. The plants from beans soaked for an hour in a solution of 3 ounces of copper carbonate and 1 quart of ammonia to 4½ gallons of water, were almost wholly free from anthracnose, while those from seed not so treated were badly diseased. This treatment can be easily applied, but the solution should not be stronger than indicated. (*N. J. R. 1891, p. 284.*)

Anthracnose of blackberry and raspberry (*Glœosporium venetum*).—A fungous disease attacking the young shoots, especially during the period of their greatest growth.

On the young shoots, near the ground, small purple spots appear. These rapidly increase in size and number, extending around the canes and upward. Soon their centers become white with a raised purple border. The white center dies, the border becomes brown, numerous spots coalesce, the epidermis is broken, and we have an effect somewhat similar to girdling with a knife. Purple spots also appear on the leaves, causing the veins to swell and the leaf stalk to curl downward. The disease is not fatal the first year, but its effect is seen when the young shoots come to bearing age, in the dwarfed, shriveled, and dried-up berries. The leaves turn yellow and fall off, and the canes blacken and die. The spores are formed beneath the epidermis, through which they burst, and, under suitable conditions, spread the disease. The Bordeaux and carbonate of copper mixtures are suggested for this disease.

A disease of the leaves similar to anthracnose is caused by *Septoria rubi.* The spots occur on both surfaces of the leaves and are larger than those of anthracnose. Upon close examination the spots are seen to be largely made up of small black specks. So far not much damage has been reported from this fungus. (*Conn. State B., 111; N. J. R. 1891, p. 306; Ohio B. vol. IV, 6; Vt. R. 1890, p. 143.*)

Anthracnose of eggplant (*Glœosporium melongenæ*).—A well-known fungous disease, which as yet has caused but little damage to the crop. It may be recognized by its producing decided pits in the fruit, upon which soon appear minute blotches bordered with pink. For preventive treatment Bordeaux mixture is recommended. (*N. J. R. 1890, p. 358, R. 1891, p. 281*).

Anthracnose of grape (*Sphaceloma ampelinum*) [sometimes called Bird's-eye rot].—A fungous disease affecting the shoots and the fruit. On the shoots its presence is first indicated by the appearance of minute brown spots with a slightly raised darker rim. These spots increase in size, the central portion becoming deeper and taking on a grayish hue. The bark is finally destroyed and in severe cases the wood beneath appears as if burned. The appearance on the leaves is similar to that just described, and when the diseased spots are numerous the leaves and shoots succumb to the parasite.

Upon the fruit the anthracnose is manifest as small gray spots, with dark brown borders. Before the gray color appears the entire spot is of a dark-brown color, more or less rounded in outline, and between the lighter-colored center and dark rim is developed a vermillion-colored band. Finally, under the attacks of the disease, the berries wither and dry up. There is no browning of the tissue or wrinkling of the skin as in the black rot, but the circular spots first seen are retained upon the dried fruit. Often the berry is attacked only on one side. This disease is not well understood.

The best treatment is to wash the vines thoroughly with a strong solution of copperas before the buds appear. Watch the vines closely, and as soon as the disease appears apply with a bellows powdered and dry slaked lime or sulphur. (*Cal. B. 70; Conn. State R. 1890, p. 102, B. 111; Mich. B. 83; N. Y. R. 1890, p. 336; Tenn. B. vol. IV, 4.*)

Anthracnose of pepper (*Glœosporium piperitum*).—A fungous disease causing irregular spots to appear on the young fruit. These increase in size as the season advances, and as they soften tend to destroy the fruit.

Another anthracnose (*Colletotrichum nigrum*) has caused considerable loss recently. It forms decayed patches upon the young and ripening fruit, and later these spots become very black, due to multitudes of bristles developed by the fungus. As a remedy for both these diseases no doubt Bordeaux mixture, or any of the copper compounds, would be found effective. (*N. J. R. 1890, p. 358.*)

Anthracnose of spinach (*Colletotrichum spinaceæ*).—A disease caused by a fungus of very rapid growth, which quickly spreads from plant to plant, often causing a heavy loss in the crop. It produces small patches upon the leaves, which soon increase in size, turn brown and then gray, followed by the drying of the leaf affected. It soon spreads to other leaves, and the whole plant becomes worthless. Owing to the nature of this plant, copper salts should not be used except when the plant is very young, and then only in moderation. Equal parts of air-slaked lime and sulphur, well raked into the soil, will aid somewhat as a preventive. All refuse should be burned, and spinach should not be cultivated in one place very long. (*N. J. R. 1890, p. 354, B. 70.*)

Anthrax [also called Charbon].—An infectious disease caused by a bacterium (*Bacillus anthracis*), which chiefly attacks cattle and sheep, but may be transmitted to goats, horses, and mules, and even to men. It is most prevalent in territories subject to inundation. Pools of stagnant water are a source of infection. Bodies of animals which have died with anthrax may spread the disease. The bacteria may be taken into the body with the food or get into the wounds in the skin. The animal attacked may drop suddenly as with apoplexy and die in convulsions, but more commonly the disease begins with high fever. In another form it starts with swellings which appear under the skin in different parts of the body. Treatment is as a rule ineffective. Disinfecting the stables with chloride of lime and the removal of cattle from fields likely to be infected are the chief preventive measures. All carcasses of animals which have died with anthrax should be carefully disposed of, perhaps best by burying them in deep pits. If practicable, all infectious material should be burned. The value of inoculation for this disease is yet doubtful. The Mississippi Station (*B. 6, B. 11, R. 1889, p. 37*) has reported on the history of anthrax in that State, and on an investigation of an outbreak among mules in the lowlands of the Delta in 1889. Observations at that time indicated that flies were active agents in disseminating the disease. Notes on anthrax in sheep are given in *N. Dak. B. 3.* See also *Ark. R. 1889, p. 106.*

Anti-gopher plant.—On account of the periodical announcement in the papers that a plant had been found with the virtue of ridding its vicinity of gophers, it was thought best at the California Station that the plant should be thoroughly tested. The plant in every case was found to be *Euphorbia lathyris*, the giant spurge or false caper, called also cross of Malta from the arrangement of the leaves. The

successes reported had been mostly from regions with sandy soils. On the adobe soil of the station the plant certainly afforded no protection. (*Cal. B. 95, R. 1889, p. 202.*)

Ants.—Where ants have become troublesome in lawns and elsewhere they may be destroyed by running a stick down into their nests in several places, pouring into the holes a teaspoonful of bisulphide of carbon, and quickly stamping the holes shut (*Mass. Hatch B. 5, R. 1888, p. 23; Mich. R. 1888, p. 98*). Where the nests can not be found place a sponge soaked with sweetened water in their runway and dip it frequently into hot water (*Mass. Hatch. B. 5*). Black ants are parasitic on the larva of the Gypsy moth and several species on the cotton worm (*Ark. B. 15; Mass. Hatch B. 19*).

Apatite.—See *Phosphates.*

Apiculture.—Under this name is included everything relating to the keeping of bees. An apiarist is employed at the Michigan and Rhode Island Stations. Experiments in bee-keeping are also conducted at the Colorado and other stations. See *Bees.*

Apoplexy, parturient, in cows.—See *Milk fever.*

Apple.—VARIETIES.—More or less extensive tests of varieties have been undertaken at many of the stations. In several Northern States, especially Iowa and Minnesota, east European, chiefly Russian, varieties have been tried with a view to securing hardy varieties. In a bulletin of the Iowa Agricultural College, 1885, descriptive notes are given on several hundred varieties from St. Petersburg, Moscow, central and southern Russia, east Poland, Silesia, and Austria. The Minnesota Station (*B. 1, R. 1886, pp. 40, R. 1888, p. 77*) has taken up this work extensively. Sixseen of the varieties tested were more hardy than the Duchess of Oldenburg. Rustian varieties have also been planted at the Colorado, Massachusetts Hatch, Indiana, New York State, and some other stations.

The responses to inquiries by the Texas Station (*B. 8*) regarding the varieties most successful in different localities indicated that Red Astrachan and Early Harvest for summer and Ben Davis and Shockly for winter were leading favorites.

(*Ark. R. 1890, p. 33; Colo. R. 1888, p. 81; R. 1889, pp. 23, 110; R. 1890, pp. 197, 214; Fla. B. 14,; Ga. B. 11; Ill. B. 21; Ind. B. 10; La. B. 8, 2d ser.; Me. R. 1889, p. 225; Mass. Hatch B. 2, B. 4; Mich. B. 55, B. 67, B. 80; Miss. R. 1888, p. 47; Mo. B. 6, B. 10; N. Y. State R. 1883, p. 34, R. 1884, p. 20, R. 1887, p. 340, R. 1888, pp. 89, 97, R. 1889, pp. 347, 355, R. 1890, p. 346; N. C. B. 72; Ohio R. 1882, p, 58, R. 1883, p. 146; Pa. R. 1888, p. 161, B. 18; R. I. B. 7; S. D. B. 26; Tenn. B., vol. V, 1, R. 1888, p. 12; Tex. B. 16; Vt. R. 1889, p. 121.*)

COMPOSITION.—See *Appendix, Table III.* Analyses are reported as follows: Substance of a young tree, *N. Y. Cornell B. 25* (fertilizing constituents); twigs, *Iowa B. 4*; fruit, *Cal., B. 88* (fertilizing constituents), *Conn. State R. 1879, p. 158* (Roxbury Russet), *Mass. State R. 1889, pp. 295, 300; N. Y. State R. 1889, p. 94* (sweet), *Mo. B. 10* (ash analysis of Ben Davis apples, green, ripe, and imperfect); sugar content of fruit, *Mass. State R. 1890, p. 301, R. 1891, p. 327* (Baldwin and Rhode Island Greening, at different stages of ripeness).

At the Iowa station (*B. 4*) the chemical composition was investigated of twigs of Duchess of Oldenburg, Borovinca, Ben Davis, and Baiken, to learn whether in midwinter there are any differences in the composition of the new growth of varieties hardy and not hardy. The results of a short study indicated the presence of somewhat more of extractable matters in the tender than in the hardy varieties, and other similar differences; and it was thought that chemical analysis might yet aid in distinguishing the classes. A somewhat extended microscopic investigation of the twigs, reported in the same connection, led to the conclusion that no constant difference in structure probably exists which could serve as a sure distinction between

varieties. Differences of structure seemed to depend on the maturity of the wood rather than upon variety.

At the Colorado Station (*R. 1888, p. 79*) observations were made for two years on the dates of leafing and shedding leaves of 174 varieties. Long retention of leaves is taken in general as indicating the need of a long season to ripen the fruit; early leafing as implying the exposure of the blossom or young fruit to cold. In *Iowa B. 13* the propositions are advanced that orchard fruits vary as much in hardiness of buds and blossoms as of tree, and that the typical ironclad tree has hardier fruit buds and blossoms than the more tender varieties. In *Minn. R. 1888, p. 403*, some account is given of efforts to adapt varieties to the conditions of that State, particularly through growing seedlings. Scions of seedlings were grafted on mature trees to learn their quality promptly. At the Iowa Station (*B. 14*) an effort at improving varieties by crossing was made.

Experiments under the auspices of the New Jersey Station (*R. 1889, p. 230*) showed that apples will not set if the blossoms are kept wet during the period of pollination. Various notes occur relating to the treatment of orchards. South Dakota Station advocates the pruning of the young trees by pinching instead of cutting the branches. The necessity of checking the tendency conspicuous in that climate to develop excessively on the north side is also pointed out. The appropriateness of a low head of a modified goblet form for fruit trees in California is alluded to in *Cal. R. 1888–'89, p. 43.* The advantage of underdraining orchards is emphasized by the California Station (*R. 1888–'89, p. 43*) and the method there used described.

Minn. R. 1888, p. 406, contains an article recommending protection of orchards by continuous rows of evergreens at intervals through them, also advising the maintenance of the trees in a vigorous condition capable of resisting trying conditions by fertilizing and prevention of overbearing.

The New York Cornell Station (*B. 9*) reports an investigation favorable to the growing of wind-breaks to protect fruit plantations.

The treatment of an old orchard at the Kentucky Station is noted (*B. 18*). At the Mississippi Station (*R. 1888, p. 47, R. 1889, p. 38*) a fertilizer experiment on a stunted orchard showed the want of potash, and night soil was successfully used on young trees. A keeping test of varieties is recorded in *Mo. B. 6*. An experiment to observe the effects of early and late picking on keeping quality made at the Ohio Station (*B. vol. II, 4*) showed some advantage in this regard from picking September 26 as compared with October 6, 13, and 20. The loss of weight of several varieties by evaporation in lying two months was also noted.

At the Mississippi Station (*R. 1889, pp. 38, 39*) a trial was made to learn whether unmarketable apples could be profitably dried, the result indicating the affirmative. Evaporated apples from western New York had been rejected by the German custom-house chemists on account of the presence of zinc; an analysis at the New York Cornell Station (*B. 25*) showed 0.583 gram of zinc to one kilogram of fruit, the zinc having been derived from the evaporating pans.

Apple aphis.—See *Plant lice.*

Apple bitter rot (*Glœosporium versicolor*).—A fungous disease sometimes associated with the brown rot. In their early stages it is difficult to distinguish them, but when more mature the bitter rot may be known by the minute pustules formed just under the skin of the apple, while brown rot always presents a smooth appearance. This disease is caused by the invasion of the tissues of the host by the fungus and the subsequent development of a network of branching threads. These cause a softening of the fruit, which assumes a dark-brown color. This fungus may start from several points and the filaments, working in the interior, cause the complete rotting of the apple, but leave a comparatively fair shell. When the pustules first appear they look like small black dots with light centers. As they grow they increase in size, break through the epidermis, and scatter their spores to attack other fruits. This fungus is carried over winter in the decayed fruit, which should always

be destroyed. It can be transmitted to sound fruit after gathering and care should be taken that no infested apples are packed with the others. Potassium sulphide solution is said to be beneficial as a remedial agent, but enough information to warrant its recommendation for this purpose is not at hand (*Conn. State B. 111; Ky. R. 1889, p. 43*).

Apple curculio (*Anthonomus quadrigibbus*).—The adult insect is a beetle three-sixteenths inch or less in length, somewhat resembling the plum curculio, but easily distinguished by its long, slender, somewhat curved beak (as long as the body in the female, but shorter in the male), and by two prominent humps on the rear part of each wing cover. These humps give it the specific name *quadrigibbus*, four-humped. In late spring or early summer the beetles begin their attacks on apples by puncturing minute holes in the fruit in which to lay their eggs, making from one to twenty holes in a single fruit. These punctures soon cause the fruit to become gnarly and ill-shaped. The eggs hatch out into soft white grubs (about one-half inch long when mature) which feed on the pulp of the fruit, completing their transformations and emerging from the fruit on its decay.

Collecting and destroying infested fruit and spraying with arsenites will hold this pest in check. Jarring the trees and collecting the beetles on sheets are also effective means of repression. (*Iowa B. 11; N. Y. State B. 35.*)

Apple maggot (*Trypeta pomonella*).—The adult insect resembles the common house fly, but is somewhat smaller. It is "readily recognized by its general black color, yellowish head and legs, dark feet, greenish, prominent eyes, white spots on the back and upper part of the thorax, three white bands across the abdomen of the male and four across the abdomen of the female, and four black bands across the wings, resembling the outlines of a turkey" (*Me. R. 1889, p. 215*).

The flies appear about June 1 and begin their attacks on apples by puncturing holes in the fruit (so small as to be hardly visible to the naked eye), in which they lay their eggs. Egg-laying continues until checked by frost in the fall, each female being capable of laying between 300 and 400 eggs. The eggs hatch in four or five days and the maggots begin at once to feed on the pulp of the fruit, which they will finally completely honeycomb. When the maggots mature (which, under favorable conditions, requires four or five weeks) they usually go into the ground a short distance and transform to pupæ, although this transformation may occur in stored fruit and windfalls and on the surface of the ground under fallen fruit or other refuse. They remain in the pupa state until the following summer, when they emerge as adult flies.

All varieties of apples, early and late, are subject to attacks. Repression of the pest is difficult. Spraying with insecticides is of doubtful efficiency. Care in collecting and destroying windfalls and refuse under trees and from bins and barrels in which fruit has been stored are efficient means of repression. Hogs and sheep running in the orchard will aid in the destruction of the larvæ and pupæ.

Some of the more important facts regarding the life history of this insect were discovered at the Maine Station, which published a detailed report on the maggot (*Me. R. 1889, p. 190*). See also *Iowa B. 13; Mich. R.1889, p. 96; N. Y. State B. 35; Ohio B. vol. III, 11.*

Apple pomace.—For composition see *Appendix, Tables I and II.* Several methods of preservation have been proposed. Ensiling has been tried, generally with success (*Ill. B. 16; Mass. State B. 21; Vt. R. 1888, p. 22*). Dessiccation by a method said to be inexpensive is discussed in *Pa. R. 1886, p. 169.* Ensiled pomace used in a feeding experiment at the Vermont Station (*R. 1888, p. 22, R. 1889, p. 51*) was a partial substitute for corn and was relished by cows. In a trial with pigs at the Illinois Station (*B. 16*) it was not well eaten.

Apple rust (*Gymnosporangium macropus*).—A disease caused by a fungus known to spend two of its phases upon totally unlike hosts, the apple and the cedar. In the

early spring the well-known "cedar apples," with their orange-colored, jelly-like filaments, may be observed. These mature spores are borne by the wind to some apple or allied tree, where they find lodgment upon the leaves. Soon a slight discoloration appears and then an orange-colored spot upon the upper side of the leaf. In a week or two black cup-like spots appear at the center, filled with spores, whose function is not yet known. Somewhat later appear from the same spot, but on the under side of the leaf, larger cup-shaped bodies, filled with rows of spores. This is called the Rœstelia stage of the fungus. These spores find their way back to the cedar, where they form what are usually considered galls, of a light brown color. In this form the fungus spends the winter, to reappear upon the return of spring as the cedar apple. When abundant this fungus may cause considerable damage to apple trees, as the leaves are liable to turn yellow and fall from the tree. Its treatment upon the apple tree is rather difficult and not attended with much success, but it may be prevented by the destruction of the cedar trees, upon which it spends the winter and earliest stage of growth. The loss of the cedar trees is not great when the injury the cedar apples may cause is considered. (*Ark. R. 1888, p. 127; Conn. State, B. 107, R. 1890, p. 98; N. J. R. 1891, p. 305; Vt. R. 1890, p. 139.*)

Apple scab (*Fusicladium dendriticum*).—A well-known fungous disease which attacks both leaves and fruit. When the attack is upon the leaf it is usually called "leaf blight or mildew." A similar fungus attacks the pear, and what is here said of the one will apply equally well to the other. The fungus lives through the winter upon the fallen fruit, leaves, and the younger twigs. In early spring it ripens a mass of spores ready to infest the coming leaves and crop. Early in the spring, small pale-green spots, definite in outline, appear on the young leaves. The spots lose their regularity of outline as they increase in size; become olive green in color and velvety, and often run together, forming large, irregular blotches. These may be found on both sides of the leaf, but are most abundant on the upper surface. Ultimately the leaves curl up and drop off. It is upon the fruit, however, that the scab is most conspicuous and injurious. It may attack the fruit when no larger than peas, or even earlier, causing the apples to fall off. If the attack is later the spots, which at first are light-colored, grow in size, assume the well-known scab-like appearance, and become brown or russet-colored, rough looking, and surrounded by a lighter border. They often cause the apple to crack and expose it to spores of other fungi, causing it to rot. If the apple matures, wherever the scabs are found it will be misshapen and hard. Damp, cool weather, especially at the time the fruit is forming, favors the growth of the fungus, and it is for this reason that it is worse some seasons than others.

Perhaps the best remedies are Bordeaux mixture, the ammoniacal carbonate of copper, and modified eau celeste. The first spraying should be before the leaves come out, the second just after the leaves appear, and the third when the fruit has formed. Subsequent spraying may be regulated according to the demands of the case. About five applications will usually suffice. For the first treatment, washing the trees with a solution of sulphate of copper, 1 pound to 10 gallons of water, is found very beneficial. The average cost of spraying per tree for the season need not exceed 30 or 40 cents. Removing fallen leaves and fruit will take away the principal source of infection in the spring. (*Conn. State B. 111; Iowa B. 13; Ky. R. 1889, p. 46; Me. R. 1890, p. 113; Mich. B. 59, B. 83; N. Y. State R. 1888, p. 154; N. C. B. 76; Ohio B. vol. IV, 9; Vt. B. 28, R. 1890, p. 142; W. Va. B. 21; Wis. B. 23.*)

Apple tree bucculatrix (*Bucculatrix pomifoliella*).—The adult insect is about one-seventh inch long. Its eggs hatch in a few days, and the minute yellow or green larvæ feed upon the upper surface of apple tree leaves, causing them to turn brown. One of its transformations is through white cocoons. These are very conspicuous in winter on the lower side of twigs, where they are placed side by side.

Burn the cocoons or apply strong kerosene to them. Spray the leaves with arsenite solutions to kill the grubs. (*N. Y. State B. 35; N. Y. Cornell B. 23.*)

Apple tree caterpillars.—Two distinct species will be referred to here: Yellow-necked (*Datana ministra*) and red-humped (*Œdemasia concinna*). These well-known insects are easily distinguished by the characters suggested in their common names. They are the larvæ of two moths, each measuring an inch or more across the wings. The caterpillars are an inch or two long when mature. They feed on the leaves and as they usually keep close together, although spinning no web, may be removed or burned. If the tree is not bearing they may be killed by spraying with arsenites. (*Me. R. 1890, p. 135; Nebr. B. 14; N. Y. State B. 35; Ore. B. 18; Ohio B., vol. III, 11.*)

Apple tree borers.—Two distinct species will be here referred to—the flat-headed (*Chrysobothris femorata*) and the round-headed (*Saperda candida*). The beetle of the round headed borer is about three-fourths inch long, brown in color, with two whitish stripes on the back. The grub is about an inch long, white, with a round, brownish head. The eggs are deposited on the bark near the ground, and upon hatching the grub enters the wood. The flat-headed borer is smaller, of a dull color, with a coppery luster. The larva is yellowish, about an inch long, with a small head. This beetle lays its eggs anywhere on the tree trunk or larger branches and the grub enters the sap wood while quite small. This grub remains in the wood two years, and that of the round-headed borer three years. Both species do great damage, especially to young trees.

Painting the trunks with whale-oil soap or thin soft soap as a preventive in the spring and digging out the grubs in the fall are recommended; also the covering of the trunk with a poisoned whitewash. (*N. J. B. 86, R. 1890, p. 513; N. Y. State B. 35; N. C. B. 78; Ore. B. 18; Me. R. 1888, p. 153; W. Va. R. 1890, p. 157.*)

Apple tree tent caterpillar (*Clisiocampa americana*).—This caterpillar is the larva of a night-flying moth, which is brownish in color and about an inch across its expanded wings. Upon the fore wings are two oblique white lines. The eggs are laid in July n clusters of two or three hundred upon the small twigs of apple, wild cherry, and some other trees. They hatch out early in the spring and the young caterpillars soon form a common web or tent. The caterpillar when full grown is about 2 inches long, body black, with yellowish hairs, white stripes, and several broken, colored stripes down the back. They feed twice a day, about the middle of the forenoon and afternoon, when the tents are nearly deserted. Each insect remains connected with the tent by a fine thread spun as it goes. When not feeding they are in or on their web. The best way to destroy them is to look for the clusters of eggs during the winter, which may be seen without much difficulty. Burning or otherwise destroying the "nests" should be done only early in the morning and late in the afternoon, when most of the caterpillars are in them. Spraying the trees in the spring with Paris green or London purple will destroy them, but is more expensive than the other methods where no other insects are present. (*Me. R. 1888, p. 159; Mass. Hatch. B. 12; Nebr. B. 14; N. Mex. B. 3; N. Y. Cornell B. 15; N. Y. State B. 35; N. C. B. 78; W. Va. R. 1890., p. 156*).

Apricot (*Prunus armeniaca*).—The planting of varieties has been reported as follows: *Ark. R. 1888, p. 57, R. 1890, p. 46; Cal. R. 1889, pp. 86, 109; Ill. B. 21; La. B. 8, 2d ser., B. 22; Mo. B. 10; N. Y. State R. 1889, pp. 353, 357; Pa. R. 1888, p. 161; R. I. B. 7; Tenn. B. vol. III, 5, R. 1888, p. 12; Tex. B. 8; Va. B. 2.*

The California Station (*B. 97, R. 1890, p. 115*) has determined the food and fertilizing constituents and the weight of fruit and percentages of flesh and stones of apricots, as compared with prunes, peaches, grapes, and oranges (see *Appendix, Table III*).

In grafting experiments at Iowa Station (*B. 10*) Myrobalan and St. Julian stocks did not thoroughly unite with Chinese and Russian varieties of apricots, even after some years. The use of a native plum stock is favored.

Arbor vitæ (*Thuya* spp.)—Various species and varieties of this evergreen have been planted at several stations. At the South Dakota Station (*B. 12, B. 15, R. 1888, p. 26*), the American arbor vitæ was found to do well and it is recommended for orna-

mental hedges. At the Kansas Station (*B. 10*) the American species (*T. occidentalis*) was not fully satisfactory, succumbing, unless protected, to the hot southwest winds. A dwarf variety, the Little Gem, appeared more promising than the ordinary form. The Siberian arbor vitæ (*T. siberica*) had been tried five years without loss of a tree, and is superior to the American in appearance, being of a handsomer green and a more regular form, and seems the most worthy of all the species for general planting.

Arbutus.—See *Strawberry tree.*

Argan (*Argania sideroxylon*).—A tree of western Barbary which is hardy at the California Station at Berkeley, but a very slow grower (*Cal. R. 1882, p. 107*). In its native country its fruit is fed to cattle and its seeds yield an oil; but it is regarded very questionable whether it will ever find much favor in California.

Arizona Station, Tucson.—Organized July 1, 1889, under act of Congress as a department of the University of Arizona. The staff consists of a director, chemist and meteorologist, irrigation engineer, botanist and entomologist, horticulturist, assistant horticulturist, assistant chemist, and foreman of the substation at Phœnix. The principal lines of work are field experiments with crops and fruits, and irrigation. Up to January 1, 1893, the station had published 2 annual reports and 6 bulletins. Revenue in 1892, $15,000.

Arkansas Station, Fayetteville.—Organized in 1888 under act of Congress as a department of Arkansas Industrial University. The station staff consists of a director, agriculturist, chemist, veterinarian, horticulturist, assistant chemist, and two assistant agriculturists in charge of substations at Pine Bluff and Newport. The principal lines of work are field experiments with crops and fruits; chemical analyses of soils, fertilizers, and feeding stuffs; and studies in veterinary science. Up to January 1, 1893, the station had published 5 annual reports and 22 bulletins. Revenue in 1892, $15,000.

Army worm (*Leucania unipuncta*).—This worm is an inch or more long, gray or dingy black in color, with black stripes and narrow lines of white on the back, and under side greenish. The head is smooth and yellowish. It is common in many places, but is only formidable when it becomes so numerous as to migrate. The female moth lays about seven hundred and fifty eggs at a time and these hatch in about six days. The grubs feed day and night, cutting off stalks of grass and grain. When increased numbers and decreased food compel they move from field to field often taking every green thing in their path.

To prevent their spread mow a wide swath about the infested region and burn everything within it. This will usually be cheapest in the end. Digging trenches and setting up boards end to end across their path, and covering the boards with tar or kerosene will check their migration and aid in their destruction. Poisoning all forage in their path with Paris green or similar arsenites is also effective. When they have been in a field it should be plowed very deep and rolled. In this way the pupæ will be killed and a future brood prevented to a great degree. (*Iowa B. 12; Ky. B. 40; Minn. R. 1888, p. 359; Nebr. B. 5; N. J. R. 1890, p. 514*).

Arsenites.—See *Fungicides* and *Insecticides.*

Artesian wells.—The name artesian is derived from Artois in France where artesian wells have long been used. In ordinary usage an artesian well means a flowing well. Such wells are usually of small diameter and of great depth, and are illustrations of the familiar tendency of water to seek its own level. The conditions necessary for the existence of an artesian well are a porous stratum which is confined between continuous impervious strata and which outcrops somewhere at a level higher than that of the well, forming a more or less perfect basin structure. If at some point in the lower part of this basin the impervious upper stratum is bored through, the water confined in the porous stratum rises almost to the level of the outcrop. The amount of water which can be obtained from artesian wells is deter-

mined by the amount absorbed by the pervious stratum where it outcrops, and this in turn is determined by the permeability of the stratum and the area exposed. Consequently there is a fixed limit to the number of artesian wells which can be put down in a given area.

Artesian wells have been used in China from early ages. India derives a considerable portion of her water supply from them, and many have been successfully sunk by the French in the Desert of Sahara (*Colo. B. 16*).

In 1890 and 1891 Congress made an appropriation for investigation into the source and availability for irrigation of the artesian and underflow waters of the great plains of the United States, to be carried on under the auspices of the U. S. Department of Agriculture. The reports of these investigations throw much light upon the nature and extent of two of the largest artesian basins of the world, that of the Dakotas or James River Valley, and that of central Texas from Fort Worth to the west and south, besides giving in detail the results of surface inquiries extending over a large part of the United States west of the Mississippi River.

About 60,000 acres of land in California, chiefly in the San Joaquin Valley, are irrigated by artesian wells, and their use for irrigation is being rapidly extended in other Western States. Such waters have been examined by the California and Colorado Stations with regard to the accumulation of soluble mineral substances (or alkali) in the soil, resulting from their continued use (*Cal. App. R. 1890, p. 51; Colo. B. 9*). See also *Alkali soils* and *Irrigation*.

Artichoke.—A trial of two varieties is noted by the New Mexico Station (*B. 4*), in which vigorous plants were developed. Germination tests of the seeds are recorded as follows: *N. Mex. B. 4; N. Y. State R. 1883, p. 67; Vt. R. 1889, p. 150.*

Jerusalem artichokes (*Helianthus tuberosus*).—Two varieties have been distributed by the California Station (*B. 95*) on the recommendation of a few growers in that State.

Chinese or Japanese artichokes.—See *Chorogi.*

Artificial digestion.—See *Foods for animals, digestibility.*

Ash in feeding stuffs.—See *Feeding farm animals* and *Appendix, Tables I and II.*

Ashes.—For ashes used in pig-feeding see *Pigs.* All plants contain a certain amount of mineral matter, which remains behind when they are burned. This incombustible matter usually forms only a small part of the plant. "The timber of freely growing trees contains but 0.2–0.4 of ash constituents in 100 of dry matter. In seeds free from husk the ash is generally 2–5 per cent of the dry matter; in the straw of cereals 4–7 per cent; in roots and tubers 4–8 per cent; in hay 5–9 per cent. It is in leaves and especially old leaves that the greatest proportion of ash is found." (Warington.)

The ash of plants always contains potassium, calcium, magnesium, iron, phosphorus, and sulphur; generally sodium, silica, and chlorine, with frequently manganese and perhaps minute traces of other elements. Since, therefore, ashes represent in kind if not in exact amount the mineral matter necessary to the growth of plants, they naturally form one of the best of fertilizers. Besides their value as plant food, they often produce beneficial physical effects on the soil. Ashes, however, are an incomplete fertilizer since they contain no nitrogen.

There are three classes of ashes which are of agricultural importance, wood ashes from household fires or from furnaces, etc.; cotton-hull ashes, resulting from the use of cotton hulls as fuel under boilers, etc., in the South; and limekiln ashes, which are a mixture of more or less lime with ashes of the fuel used in the kilns.

The value of wood ashes depends upon the kind of wood used, freedom from impurities, and care in preservation.

According to analyses (*Ga. B. 2*) of samples of trees growing as nearly as possible under like conditions and of medium age, different kinds of wood (exclusive of bark) having a uniform water content, contain the following amounts of mineral constituents:

Composition of the ash of different woods.

	10,000 pounds of wood contains—				Pure* ash contains—			
	Potash.	Phosphoric acid.	Lime.	Magnesia.	Potash.	Phosphoric acid.	Lime.	Magnesia.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Dogwood (*Cornus florida*)	19.02	5.72	26.41	4.67	28.04	8.51	38.93	6.80
Sycamore (*Platanus occidentalis*)	18.06	9.55	24.73	0.49	23.17	12.23	31.62	0.62
Post oak (*Quercus obtusiloba*)	16.85	6.96	35.61	5.28	21.92	9.00	46.39	6.88
Ash (*Fraxinus americana*)	14.94	1.15	7.60	0.10	46.04	3.58	23.57	0.60
Red oak (*Quercus rubra*)	13.95	5.98	27.40	3.05	24.66	10.55	48.26	5.38
Hickory (*Carya tomentosa*)	13.80	5.83	18.40	4.87	28.60	11.97	37.94	10.04
White oak (*Quercus alba*)	10.60	2.49	7.85	0.90	42.16	9.48	29.85	3.43
Magnolia (*Magnolia grandiflora*)	7.13	3.19	14.21	2.94	19.54	8.75	38.94	8.05
Georgia pine (*Pinus palustris*)	5.01	1.24	18.04	2.03	15.35	3.82	55.24	6.25
Yellow pine (*Pinus mitis*)	4.54	0.96	15.16	0.74	19.70	4.18	65.53	3.20
Black pine (*Picea nigra*)	3.02	0.92	12.46	0.10	14.30	4.33	58.98	0.50
Chestnut (*Castanea vulgaris*)	2.90	1.09	7.93	0.34	18.10	6.76	49.18	2.11
Old field pine (*Pinus tædia*)	0.79	0.73	12.12	1.17	3.85	4.11	67.73	6.54

* Free from carbon and carbonic acid.

The fact that these ashes were pure and prepared from the wood only, explains why the percentages of mineral constituents are so much higher than those found in the average ashes in the market, which are as follows for unleached ashes: Moisture 12.50, potash 5.25, phosphoric acid 1.70, lime 34, magnesia 3.40. Ashes which have been subjected to leaching show a reduced percentage of potash and an increased percentage of moisture, but otherwise remain practically unchanged. The average composition of leached ashes as compiled from analyses by the Massachusetts and Connecticut stations is as follows: Moisture 30.22, potash 1.27, phosphoric acid 1.51, lime 28.08, magnesia 2.66 per cent.

Limekiln ashes differ in composition from the leached ashes principally in their lower percentage of moisture and higher percentage of lime. The lime exists to a considerable extent (8 per cent or more) as caustic or quicklime and not as carbonate, which is the almost exclusive form in leached and unleached wood ashes. The average composition of limekiln ashes compiled from a large number of analyses is as follows: Moisture 15.45, potash 1.20, phosphoric acid 1.14, lime 48.50, magnesia 2.60 per cent.

Cotton-hull ashes have been on the market since 1880 and have come into great demand as a cheap potash supply, especially among the tobacco growers of New England. The cotton hulls are now being utilized for paper-making and it is probable that the supply of ashes in the future will be either very much reduced or entirely cut off. The composition of the ashes as put upon the market is extremely variable. The average composition is as follows: Moisture 7.80, potash 22.75, soluble phosphoric acid 1.25, reverted phosphoric acid 6.50, total phosphoric acid 8.85, lime 9.60, magnesia 10.75 per cent. The potash varies from 10 to 42 per cent and phosphoric acid from 3 to 13.5 per cent. The potash exists largely as carbonate, which is readily available to plants, but there is also a considerable percentage of silicate of potash which is difficultly available. The value of cotton-hull ashes depends almost exclusively upon the amounts of potash and phosphoric acid they contain. This is not true of the other kinds of ashes described above. The lime contained in limekiln and wood ashes is of considerable agricultural importance on account of its well-known effect on the mechanical condition of soils, especially such as are light and sandy, the general experience being that such soils are rendered more moist by applications of wood ashes. Besides this wood ashes tend to correct "sourness" of the soil and promote nitrification by supplying the carbonate of lime necessary to that process.

The common practice of fermenting bone with ashes has been a subject of investigation at the New Hampshire Station (*R. 1888, pp. 10, 67*) with the result of showing that "this method is not a satisfactory one, for in all cases where ashes were used the whole of the soluble phosphoric acid was changed into either insoluble or reverted, while considerably over half of the reverted or citrate-soluble phosphoric acid was made insoluble." It possesses the further disadvantage of being likely to cause a loss of nitrogen from the bone. Still the fact remains that the process furnishes a convenient and cheap means of reducing to a desirable condition for fertilizing purposes materials which would otherwise probably remain worthless on the farm.

The scarcity and inferior quality of ashes on the market has led the Connecticut State Station (*R. 1891, p. 85*) to seek a desirable substitute for them. As a result of its investigations three mixtures are suggested as equivalent to 1 ton of good ashes: (1) 20 bushels of burned oyster shells (40 pounds to the bushel) and 500 pounds of cotton-hull ashes, cost $11.15; (2) 20 bushels of oyster-shell lime, 220 pounds of high-grade sulphate of potash, and 150 pounds of cheap steamed bones, cost $11.10; and (3) 20 bushels of oyster-shell lime, 150 pounds of cheap steamed bones, and 220 pounds of muriate of potash, cost $9.45. (*Conn. State R. 1881, pp. 54, 66, R. 1883, p. 67, R. 1889, p. 108, R. 1891, p. 85; Ga. B. 2; Me. R. 1885–'86, p. 29; Mass. State R. 1891, p. 306; Mich. B. 15; N. H. R. 1888, pp. 10, 67; N. C. R. 1881, p. 47.*)

Ash trees (*Fraxinus* spp.).—An economic description of the white ash (*F. americana*), red ash (*F. pubescens*), and the green ash (*F. viridis*) is given by the Alabama College Station (*B. 3, n. ser.*). The wood of all these species is similar, but that of the white ash is considered to be the best for many purposes. The bark of this species may be used for tanning and dyeing and its wood and leaves for medicinal purposes. At the South Dakota Station (*B. 12, B. 15, B. 20, B. 23, R. 1888, p. 23*) both the white and green species have done well, but the latter is likely to be more serviceable in that State, being a native tree able to endure heat and drought. "This tree has been more uniformly successful in prairie plantations than any other. When planted among box elder it equals that tree in height at the end of seven years, and thereafter is the more rapid grower." Three species are catalogued (*Nebr. B. 18*) as native in Nebraska. Different species of ash, especially the white, are mentioned in lists of trees planted in forestry experiments (*Cal. R. 1888–'89, p. 179; Minn. R. 1890, p. 38; N. Mex. B. 4; N. Y. State R. 1890, p. 348; Ore. B. 4*).

The American and European mountain ash trees (*Pyrus* spp.), belonging to a different family, are mentioned by some stations as ornamental trees.

Asparagus (*Asparagus officinalis*).—Variety tests of 5, 6, and 2 varieties, respectively, are reported as follows: *Mich. B. 67; Minn. R. 1888, p. 256; Utah B. 3.* Successful experiments in growing this vegetable have been made by the Florida (*B. 1*) and New Mexico (*B. 4*) Stations.

For analyses made at Iowa and Massachusetts State Stations, see *Appendix, Table III.*

The growth of the roots was observed at the New York State Station (*R. 1884, p. 308*). The roots developed in the same way whether the ground was trenched or not. The fact that the new roots grew out above the old ones seemed to favor the French practice of planting in trenches and year by year drawing the soil in.

At the Ohio Station (*B. Vol. III, 9*) observations were made for two seasons on the relative yield of the male and the female plants. The male was found to gain over the female for four periods of ten days each, respectively, 76, 52, 63, and 31 per cent. Likewise at the New Mexico Station (*B. 4*) it was found more profitable to raise the male plant.

Germination tests of asparagus seed are noted as follows: *N. Y. State R. 1883, p. 67; Vt. R. 1888, p. 100.*

In the Ohio bulletin referred to above the use of rubber bands in bunching for market is recommended.

Association of American Agricultural Colleges and Experiment Stations.—Organized in 1887 to promote the general interests of agricultural science and education. The membership includes one delegate from each of the agricultural colleges and experiment stations in the United States and from the Office of Experiment Stations. Annual conventions are held in different parts of the country, at which, besides discussions on general topics, papers on investigations in agricultural science are read before the general association or sections on college work, agriculture and chemistry, botany and horticulture, entomology, and mechanic arts. The proceedings of the several conventions are published as bulletins of the Office of Experiment Stations.

Association of Official Agricultural Chemists.—See *Chemistry.*

Australian fern tree.—See *Grevillea.*

Ayrshire cows.—See *Cows, tests of dairy breeds.*

Babcock milk test.—See *Milk tests.*

Baby separator.—See *Creaming of milk.*

Bacteriology.—The work of the stations in this line includes investigations of the bacteria which are found in soils, plants, and animals, and in milk and its products. Bacteria are microscopic organisms, usually classed as plants, which develop in the air, water, soil, plants, animals, or vegetable and animal products. By their growth they cause chemical and physical changes in their hosts. Some of these changes are beneficial and others are injurious. Thus certain kinds of bacteria produce diseases in plants or animals, or render such substances as milk or butter unfit for food. Other kinds promote the acquisition of the nitrogen of the air by plants (especially legumes) or give the peculiar flavor to butter, which makes it command a high price in the market. Bacteriology is so young a science that much still remains to be learned about these minute organisms before very definite statements can be made regarding their nature and the methods for their treatment. Enough is already known, however, to make their investigation of great importance. Work in bacteriology at the stations will be referred to under various diseases of plants and animals, dairying, legumes, green manures, etc.

Bamboos.—Several species of bamboo have been tested by the California Station and by individuals in the State (*Cal. R. 1882, p. 114, R. 1885–'86, p. 127, R. 1888–'89, p. 139, R. 1890, p. 232*). In the report for 1882 general statements are made regarding the usefulness of bamboos, and descriptions are given of several species grown at the station or on private grounds. In a garden at Oakland "a complete little grove of bamboos can be seen, with cane averaging 20 to 30 feet in height and 1½ to 2½ inches in diameter. For some years the shoots had been weak and were cut off with the mower. They then became vigorous, and, being left undisturbed, reached a height of 20 feet in a couple of months." In the same vicinity were growing vigorously the Metake variety, a black-stemmed species (*Phyllostachys nigra*), and various others. Of other species growing in the station collection *Arundinaria falcata*, the Ringal or Nigala bamboo from the Himalayas, was the most promising. *Bambusa stricta* seemed to require more heat. Many species of bamboos, especially those from Japan, are considered worthy of trial in California. Later reports of trials made in various parts of the State tend to confirm the expectations entertained by the station.

Barberries (*Berberis* spp.).—A promising growth of the common barberry (*Berberis vulgaris*) is noted in *Minn. R. 1888, p. 287.*

The edible barberry (*B. heteropoda*), a native of Turkestan, is noted in *Cal. R. 1882, p. 102.* It had proved adapted to the station climate, but was of slow growth.

The tree or Amur barberry (*B. armurensis*) is recommended by the Iowa Station (*B 16*) for ornamental planting. It forms a neat round-topped tree of small size, with large scarlet fruit in late summer and fall.

Bark lice.—See *Plant lice* and *Oyster-shell bark louse.*

Barley (*Hordeum* spp.).—The work of the stations on this grain includes tests of varieties, analyses, and experiments with fertilizers. The cultivated species may be classified as follows: Two-rowed (*Hordeum distichum*), six-rowed (*H. vulgare*), and awnless (*H. trifurcatum*) (*N. Y. State R. 1884, p. 385*).

VARIETIES.—Among the six-rowed varieties tested, Manshury has been more generally satisfactory than any other variety. Chevalier is an excellent two-rowed variety. Manshury was discovered by a scientific traveler in 1859 in the mountainous region of Manchoori, China, and brought to the experimental garden at Sans Souci, Germany. It was introduced into this country by H. Grunow, of Mifflin, Wisconsin. The first station to test it was the Wisconsin Station. (For a history of this variety, see *Wis. R. 1883* and *Pa. B. 6.*) The cost of raising Manshury barley in Iowa has been estimated to be about 11 cents per bushel (*Iowa B. 16*).

(*Ala. Canebrake B. 9; Cal. R. 1890, p. 273; Colo. R. 1890, p. 16; Me. B. 18, R. 1887, p. 106, R. 1889, p. 145; Mich. B. 46; Nebr. B. 12, B. 19; N. Y. State B. 12* (*1882*), *R. 1883, p. 141, R. 1884, pp. 81, 385, R. 1889, p. 288; Pa. B. 6, B. 10, R. 1889, p. 23; S. Dak. B. 11, B. 17, B. 21; Tenn. B. vol. III, 2; Utah R. 1891, p. 59; Wis. B. 11, B. 13, B. 17, R. 1883, p. 111.*)

COMPOSITION.—See *Appendix, Tables I and II; N. Y. State R. 1890, p. 172* (hay); *Mass. State R. 1890, p. 293* (straw).

FERTILIZER TESTS.—None of the tests thus far conducted by the stations have been continued long enough to give more than suggestive results. In California, on soil of decomposed granite deficient in phosphates and humus, nitrate of soda and bone meal combined doubled the yield (*Cal. R. 1890, p. 275*). In Maine, ground South Carolina rock gave better results than acid South Carolina rock (*Me. R. 1890, p. 92*). In Indiana barnyard manure was more effective than commercial fertilizers (*Ind. B. 34*). In Arkansas pea vines plowed under increased the yield of barley (*Ark. B. 18*). See also *La. B. 8, 2d ser.; Fla. B. 14.*

FEEDING EXPERIMENTS.—See *Cows* and *Pigs*.

Barns.—See *Farm buildings*.

Barnyard manure.—This term is used to include the pure solid and liquid excrement of the different classes of farm live stock, as well as the more or less weathered and leached mixture of animal excrement and litter commonly known as farmyard or barnyard manure.

SOURCES AND COMPOSITION.—The quality of barnyard manure depends upon the food used, the amount of litter added, and the care taken in preservation. As showing the amount and value of the manure produced by different animals under ordinary conditions of liberal feeding, the following figures, obtained in experiments at the New York Cornell Station (*B. 27*), are of interest:

Amount and value of manure produced by farm live stock.

Animals.	Food.	Food consumed per animal daily.	Manure excreted per animal daily.	Composition of manure.			Value of manure.		
				Nitrogen.	Potash.	Phosphoric acid.	Per ton.	Per animal daily.	Per 1,000 pounds live weight daily.
		Lbs.	*Lbs.*	*Per ct.*	*Per ct.*	*Per ct.*			
Cows	Hay, silage, beets, wheat bran, corn meal, cotton-seed meal, malt sprouts.	75.5	81.5	0.50	0.29	0.45	$2.37	$0.093	$0.082
Horses*	Hay and oats	......	52.5	0.47	0.94	0.39	2.79	0.073	0.052
Sheep	Grain, beets, and hay	5.3	7.2	1.00	1.21	0.08	4.19	0.015	0.106
Swine	Corn meal, or corn meal and flesh meal.	3.6	3.5	0.83	0.61	0.04	3.18	0.006	0.047

*Work horses. Estimates were made on the assumption that three fifths of the manure was collected.

This table shows the variation in composition of manure from different animal under ordinary feeding. A change in food in each case would result in a change in composition of the manure obtained, since it is well demonstrated that the manure from an animal fed upon a given food contains the larger part of the fertilizing ingredients, nitrogen, potash, and phosphoric acid of the food, and in almost the same relative proportions. This point is well illustrated by the following experiments made at the Maine Station (*R. 1885–'86, p. 42*): Two lots of sheep were fed two different rations, one having a basis of corn meal but comparatively poor in fertilizing constituents, and the other having a basis of cotton-seed meal and richer in fertilizing constituents. The amounts of the different fertilizing ingredients fed and excreted in the two rations in five days were as follows:

Fertilizing constituents consumed and excreted by sheep.

	Hay and cotton-seed meal.		Hay and corn meal.*	
	In food.	In manure.	In food.	In manure.
	Ounces.	*Ounces.*	*Ounces.*	*Ounces.*
Nitrogen	3.6	3.9	1.6	1.5
Phosphoric acid	1.4	1.3	0.5	0.4
Potash	2.2	2.0	1.1	0.8

* Calculated from amount excreted during four days.

The results obtained are summarized as follows:

"The amounts of nitrogen, phosphoric acid, and potash in the manure residue stand in direct relation to the amounts of the same ingredients in the food, the loss in the present instance averaging only about 10 per cent.

"The urine contained nearly half the potash of the total excreta, and from half to three-fourths the nitrogen, but no phosphoric acid, the latter being wholly in the solid excrement."

We see here the intimate relation existing between the feeding of live stock and the fertility of the soil. In the different products sold from the farm there is carried away a certain amount of fertilizing materials. The following table, adapted from *Pa. R. 1890, p. 27,* shows the fertilizing value of some of the more common farm products:

Manurial value of farm products.

	Pounds per ton.			Value per ton.				Manurial value of $10 worth.
	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.	Total.	
Meadow hay	20.42	8.2	26.4	$3.47	$0.57	$1.06	$5.10	$5.10
Clover hay	40.16	11.2	36.6	6.83	0.78	1.46	9.07	9.07
Potatoes	7.01	3.2	11.4	1.19	0.22	0.46	1.87	0.12
Wheat bran	49.15	28.6	54.6	8.35	2.00	2.10	12.45	7.78
Linseed meal	105.12	32.2	24.8	17.87	2.25	0.99	21.11	7.54
Cotton-seed meal	135.65	29.2	56.2	23.06	2.04	2.25	28.35	10.12
Wheat	37.53	10.6	15.8	6.38	0.74	0.63	7.75	2.58
Oats	36.42	12.4	8.8	6.21	0.87	0.35	7.43	3.86
Corn	33.06	11.8	7.4	5.62	0.83	0.30	6.75	3.78
Barley	39.65	9.0	15.4	6.74	0.63	0.62	7.99	2.96
Milk	10.20	3.4	3.0	1.73	0.24	0.12	2.09	0.88
Cheese	90.60	23.0	5.0	15.40	1.61	0.20	17.21	0.69
Live cattle	53.2	37.2	3.4	9.04	2.60	0.14	11.78	1.18

"We learn from the above table that the farmer who sells a ton of hay, for example, sells in this ton of hay fertilizing ingredients which, if purchased in the form of commercial fertilizers, would cost him about $5.10; that if he sells 2,000 pounds of wheat, he sells an amount of nitrogen, phosphoric acid, and potash which it would cost him $7.75 to replace in his soil in the form of commercial fertilizers. [Or looking at it from a somewhat different standpoint] a farmer who sells, for example, $10 worth of wheat, sells with it about $2.58 worth of the fertility of his soil. In other words, when he receives his $10 this amount does not represent the net receipts of the transaction, for he has parted with $2.58 worth of his capital, that is, of the stored-up fertility of his soil, and if he does not take this into the account he makes the same mistake a merchant would should he estimate his profits by the amount of cash which he received and neglect to take account of stock."

If now the farmer, instead of selling off his crops, feeds them to live stock on the farm as far as possible, a large proportion of this fertility, as has been shown above, is retained on the farm; and "if the business of stock feeding is carried to the point where feed is purchased in addition to that grown on the farm, a considerable addition may in this way be made to the fertility of the farm at an almost nominal cost, since it is assumed that feed will not be bought unless its feeding value will at least pay its cost." (*Pa. R. 1890, p 27; Mass. State B. 36.*)

Deterioration and preservation.—The two chief causes of deterioration of barnyard manure are fermentation, whereby a certain amount of nitrogen is set free, and weathering or leaching, which results in a loss of the soluble fertilizing elements of the manure.

Laboratory experiments at the North Carolina Station (*B. 63*) with small amounts (100-gram lots) of manure to observe the proportion of ammonia escaping from manure in mass, showed a loss of only 3.36 per cent of the nitrogen originally present in the manure. It is possible that from larger masses the loss would have been larger, although experiments at the New York Cornell Station (*B. 13*) have shown that no appreciable loss takes place where manure simply dries, and it is the generally accepted view that the loss of nitrogen under such conditions is insignificant. Manure loosely piled is in the most favorable condition both for destructive fermentation and for leaching. Experiments at the New York Cornell Station (*B. 13*) show that "horse manure thrown into a loose pile and subjected to the action of the elements will lose nearly half of the valuable fertilizing constituents in the course of six months; that mixed horse and cow manure in a compact mass and so placed that all water falling upon it quickly runs through and off is subjected to a considerable, though not so great a loss."

Further experiments on a larger scale (*B. 27*) in general confirmed these results, showing that the loss of fertilizing constituents under ordinary conditions of piling and exposure during the course of the summer amounted to about 50 per cent of the original value of the manure.

In experiments at the New York State Station (*B. 23*) it was shown that on exposure to weather cow manure lost 65 per cent of its weight, and compost of which muck was the leading constituent, about 30 per cent. There was a loss in percentage of each fertilizing constituent except phosphoric acid, amounting in the aggregate to $2.50 per cord of manure, and $1.18 per cord of compost.

From somewhat similar experiments at the Kansas Station (*R. 1888, p. 10*) the conclusion was drawn "that farmyard manure must be hauled to the field in the spring, otherwise the loss of manure is sure to be very great, the waste in six months amounting to fully one half of the gross manure and nearly 40 per cent of the nitrogen that it contained."

The comparative value of leached and unleached manure has been carefully tested at the Ohio Station (*B. vol. V, 3*) on corn and wheat, and mixtures of clover and timothy. The experiments show a wide difference in value between the leached and unleached manure and indicate that the margin of profit on open-yard manure is extremely small.

Manure may be preserved by preventing as far as possible destructive fermentation and leaching. The first result is secured largely by keeping the manure moist and more or less compact, to prevent free access of air, and the second by storing under cover.

In practice it is impossible to completely prevent the formation of ammonia gas, and so the addition of various materials to the manure to absorb this gas has been recommended. Dry loam may be used to advantage, but sulphate of lime (gypsum), superphosphate, or kainit in moderate quantities are generally more satisfactory. It has been the general experience that probably the best way to utilize farm manure in general is in compost with such materials as supplement and conserve its fertilizing constituents (see *Composts*).

The value of barnyard manure depends not so much upon the actual amounts of the essential elements of plant food, since analysis shows these to be comparatively small, as upon its effect on the physical qualities of the soil. It not only improves the mechanical conditions of both light and heavy soil, but it induces fermentative changes in the soil which render available latent plant food, and promotes the capillary flow of soil water toward the surface, thus augmenting both the supply of water and plant food to the crop (*Wis. R. 1891, p. 111*).

FIELD EXPERIMENTS.—A review of the experiments with barnyard manure shows that the high esteem in which it has long been held is fully warranted. On the prairie soils of Illinois it has shown its superiority to commercial fertilizers (*Ill. B. 4, R. 22*), although it appears that to base its value for such soils on the price of the constituents of commercial fertilizers is somewhat misleading. An application of 20 tons per acre on wheat in Kansas (*B. 11*) gave an increase of only 5 bushels per acre.

On the dry soils of Mississippi (*R. 1890, p. 10*), which are deficient in organic matter, it has been used with very favorable results.

In a five-years' trial at the Indiana Station (*B. 23*) of gas lime, superphosphate, and stable manure on corn, the results were best with the manure both as regards increase of crop and permanency of effect.

Comparative experiments at the New York Cornell Station (*B. 21*) with nitrate of soda, muriate of potash, and stable manure on tomatoes demonstrated the superiority of the latter, and showed that it may be profitably used in abundance on this crop.

Comparative tests of commercial fertilizers and barnyard manure on corn at the Kentucky Station (*B. 17*) showed best results with the latter.

The results of experiments on potatoes (*Ga. B. 8; Ind. B. 31; Mich. B. 85; N. J. B. 80; N. Y. State R. 1889, p. 223; R. I. R. 1890, p. 23*) are equally favorable, the principal objection urged against it being its liabilty when used close to the seed to promote the formation of scab (*Mass. State R. 1889, p. 214; Ohio B. vol. III, 1*). The manure doubtless furnishes conditions well suited to the growth of the scab fungus as well as of other fungoid diseases, but experiments at the Connecticut State Station (*R. 1891, p. 153*) go to show that the chief danger lies in liability of infecting the potatoes with the fungus already living in the manure. Where the manure is not previously contaminated scab is not necessarily increased.

METHODS OF APPLYING.—It is the general experience with barnyard manure, as with all bulky organic manures, that in order to secure the best results time must be allowed for thorough decomposition in the soil. This is noticeably true where it is used for tobacco and sugar beets. There is much difference of opinion in regard to the question whether manure should be incorporated in the soil as soon as applied or left for a time spread on the surface. The following experiments of the New Hampshire Station (*B. 6*) bear on this question: On one acre the manure was plowed under in the fall, on a second it was spread on the surface in the fall, and on a third it was spread on the surface in the spring. The yield was largest with the second method and smallest with the third. In experiments on oats at the Maine Station

(*R. 1891, p. 146*) spring manuring gave the largest yield of grain and fall manuring the largest yield of straw.

Applications in the trench with potatoes have been known to produce injurious effects (*Mass. State R. 1889, p. 214; Ohio B. vol. III, 1; Va. B. 8*), but as a mulch between the rows of potatoes at the rate of 10 cords per acre the results have been highly satisfactory (*Mich. B. 85*).

(*Ala. Canebrake B. 10, B. 11; Ala. College B. 16, n. ser.; Ark. B, 19; Conn. State B. 1891, p, 101; Conn. Storrs R. 1888, p. 47; Ga. B. 8, B. 11, B. 13, B. 15; Ill. B. 4, B. 8; Ind. B. 23, B. 31, B. 32; Iowa B. 17; Kans. B. 11; R. 1888, p. 10, Ky. B. 17; Me. R. 1885–'86, p. 42, R. 1890, p. 96, R. 1891, pp. 138, 146; Mass. Hatch B. 9, B. 18; Mass. State B. 36, R. 1889, p. 214, R. 1890, p. 135; Mich. B. 85; Minn. B. 8; Miss. R. 1890. p. 38; N. H. B. 5, B. 6; N. J. B. 80; N. Y. Cornell B. 13, B. 21, B. 27; N. Y. State B. 27, R. 1889, p. 256; N. C. B. 61, B. 63, R. 1879, p. 59, R. 1880, p. 119, R. 1882, p. 79, R. 1885, p. 48, R. 1887, p. 56, Ohio B. vol. III, 1, B. vol. V, 2, 3; Pa. R. 1890, p. 27; R. I. R. 1890, p. 18; Tex. R. 1889, p. 98; Va. B. 8.*)

Basella (*Basella alba*).—A twining herb known also as Malabar nightshade, native in India; the white variety is cultivated in France, and was grown at the New York State Station (*R. 1885, p. 194*). It has thick, fleshy leaves, which are used as a substitute for spinach.

Basswood (*Tilia americana*) [also called American linden].—This tree is briefly described from an economic point of view in *Ala. B. 2, n. ser.*, and is recommended for a shade tree in *Iowa B. 16*. In *Mich. B. 39* it is praised for its beauty, vigorous and rapid growth, endurance of transplanting, and value as a honey tree. It is also praised as an ornamental tree by the Minnesota Station (*B. 24*). At the South Dakota Station (*B. 12, R. 1888, p. 24,*) this tree grew fairly well in the lawn, though plantations of small trees in the nursery almost entirely failed. It was there looked upon with favor only as an ornamental tree.

Bat guano.—See *Appendix, Table IV.*

Bean.—The work of the stations has been chiefly the testing of varieties, especially of the French or kidney bean (*Phaseolus vulgaris*) and the Lima bean (*P. lunatus*).

VARIETIES.—In *N. Y. State R. 1883, p. 235,* tabulated data are given for 102 varieties, 88 of which are classified on a scheme proposed by H. H. Wing, partly after Martens of Germany, which is based on the size, shape, and color of the ripe seed. (See also *R. 1882, p. 89.*) In *N. Y. State R. 1883, p. 243,* a number of cases of volunteer variation and cross-fertilization among the varieties tested are described. At the Kansas Station (*R. 1889, p. 133*) a trial was made in 1889 of 81 varieties of kidney beans and 10 of Lima, classified mainly according to the scheme mentioned above. In 1890, 194 varieties were planted, of which only 19 withstood the severe drought of the season (*Kans. B. 19*).

The asparagus bean (*Dolichos sesquipedalis*), "a tall pole bean, needing a warmer climate than the northern United States for full development," is described in *N. Y. State R. 1883, p. 259.*

The horse bean (*Vicia faba*) has been planted as a forage plant at several stations.

Besides the soja or soy bean, frequently tested (see *Soja bean*), several other varieties of Japanese beans have been planted. At the Kansas Station (*B. 18, B. 19, B. 32*) *Dolichos cultratus, Mucuna capitata, Canavalia* sp., and varieties of the Adzuki bean (*Phaseolus radiatus*) were grown, as also varieties of the soja bean. These are specifically described (*B. 18*), and it is estimated that though productive and nutritious they are not likely to meet the American taste except as specially cultivated. In *Kans. B. 32,* however, 2 Adzuki varieties are described, and it is stated that authorities concede this to be the best-flavored bean in existence. Samples were submitted to several housekeepers for trial, all but two of whom recommended the bean. They were very successfully grown at the station. The red and white Adzuki beans were

grown with success at the Massachusetts Hatch Station (*B. 7, B. 18*). It was regarded doubtful whether this class of beans would prove valuable here, as the confections made from them by the Japanese are considered insipid by foreigners. Two analyses of this bean are given in *Mass. R. 1891, p. 318.*

The root systems of the scarlet runner bean and the Boston dwarf wax were observed at the N. Y. State station, showing for the deeper roots of the former a length of 2½ feet and for the longer horizontal roots a length of at least 4 feet.

(*Ala. Canebrake B. 1; Ala. College B. 7, n. ser. B. 20, n. ser.; Ark. R. 1889, p. 98; Colo. B. 2, R. 1888, p. 138, R. 1889, pp. 35, 100, 120, R. 1890, pp. 193, 205, 210; Iowa B. 7; Ky. B. 32; La. B. 3, 2d ser; Me. R. 1890, p. 102; Md. R. 1889, p. 60; Mass. Hatch B. 4; Mich. B. 70; Minn. R. 1888, p. 259; Nebr. B. 12; Nev. R. 1890, p. 19; N. Mex. B. 4; N. Y. State R. 1885, p. 190, R. 1886, p. 250, R. 1887, p. 332, R. 1888, p. 110, R. 1889, p. 314, R. 1890, p. 285; Pa. R. 1888, p. 136, B. 10, B. 14; Utah B. 10; Vt. R. 1889, p. 125.*)

Composition.—See *Appendix, Table III.*

Fertilizer tests.—Experiments with fertilizers are reported as follows: *Ga. B. 14; R. I. R. 1890, p. 154.*

Seed tests.—Experiments in planting large and small seeds during two years are reported from the New York State Station (*R. 1889, p. 364*). The second year the largest and the smallest beans produced the previous year by both the large and the small seed, were planted. The number of seeds which germinated and the history of the plants were observed. The results indicated that while the small seed vegetated more quickly, the large seed produced fully as many plants, which had more vigorous growth. Germination tests of beans are reported as follows: *Ark. R. 1889, p. 98; N. Y. State R. 1883, pp. 59, 66; Ohio R. 1883, p. 170, R. 1885, p. 169, R. 1886, p. 254; Ore. B. 2; Pa. R. 1889, p. 164; Vt. R. 1889, p. 100; S. C. R. 1888, pp. 62, 82.*

Greenhouse culture.—In *N. Y. Cornell R. 1890, p. 171,* instructions are given for the winter forcing of beans, based on experience at the station. The necessity of having bottom heat is urged. The Sion House is recommended as a good variety for winter forcing.

Bean anthracnose.—See *Anthracnose of bean.*

Bean weevil (*Bruchus obsoletus*).—The adult beetle greatly resembles the pea weevil beetle, but is about half as large. It is about one-eighth inch long and brownish-black in color. It lays its eggs upon the outside of the young pod, and upon hatching the larva finds its way into the bean, where it spends the remainder of the season, to emerge in the spring. A single larva to a bean is not the rule, as in the case of the pea weevil, but from 6 to 12 grubs are found inside a single bean. For remedies and preventive measures, see *Pea weevil.* (*Kans. R. 1889, p. 206; Ky. B. 40; Mass. Hatch. B. 12; Miss. B. 14.*)

Beech trees (*Fagus* spp.)—The American beech (*Fagus ferruginea*) is briefly described from the economic point of view in *Ala. College B. 3.* Ornamental varieties of the European beech (*F. sylvatica*) are named in the lists of a few stations.

Bee plants.—Several plants have been tested with reference to their value as bee food, chiefly at the Michigan Station (*B. 65, R. 1888, p. 40, R. 1889, p. 97*).

The Chapman honey plant (*Echinops sphærocephalus*) is a thistle-like plant, with the flowers in globular heads and opening gradually from the lower margin to the center. This plant was found to continue long in bloom, covering the season of honey dearth, and was visited freely by the bees. But it does not blossom till the second year and nearly exhausts itself by once seeding; the seed is very difficult to separate on account of its annoying barbed awns, and is not sure to grow. If self-seeded the plant affords no honey again until the second year. The same plant was tested at the Colorado Station (*R. 1890, p. 55*), where a good stand was obtained and the flowers were visited by the bees from morning till night from July 21 to August 24.

The Rocky Mountain bee plant (*Cleome integrifolia*) grows from 1 to 3 feet high, has smooth compound leaves, and umbelled flowers, which begin to open from below and continue for a long time. At the Michigan Station (*B. 65*) the seed did not germinate well and the flowers did not secrete much nectar. A previous year, however, the plants fairly swarmed with bees and on account of its favorable blooming season kept them storing honey through the usual period of dearth.

The Melissa honey plant is a very sweet mint, which grows about a foot high and bears a beautiful white blossom. It did well at the Michigan Station (*B. 65*), blossomed freely, and was very generally visited by the bees, blooming from early in July for a month or more. Unfortunately it is an annual, does not seed itself, and must be planted each year. It is considered doubtful if this would pay. On 3 acres of Melissa the bees had swarmed in early August—a thing unprecedented in the State.

In *Mich. R. 1889, p. 90*, Japanese buckwheat is recommended for those who wish to plant buckwheat, both because more productive and better than other kinds and because more valuable for bee keepers. It can be planted the middle of June, and in that case will blossom between basswood and late flowers, ending in time to avoid mixing its honey with the better product derived from the asters and golden-rods.

In *Mich. R. 1888, p. 41*, the pleurisy root (*Asclepias tuberosa*) is mentioned as a promising honey plant. The excellence of basswood or linden as a honey tree is noted (*Mich. B. 39*). In *R. I. B. 9* the principal sources of honey supply for a season are named, viz, during June, white clover, blackberry, and charlock (*Brassica sinapistrum*); in the fall, a light variety of golden-rod and various wild asters. The charlock honey was of a light amber color and the mustard flavor was plainly noticeable. "Aster honey is a pale amber, and when ripe, or after its weedy odor and flavor have passed off, is very thick, clear, and sparkling, and has a delicious flavor, while golden-rod honey is darker and thinner, and has a rather strong or rank flavor."

Bees.—The Colorado, Michigan, New York State, and Rhode Island Stations have conducted experiments in bee-keeping and reported results on the investigation of various kinds of bees and experiments in crossing. The common black and the Syrian bees are not inclined to be very amiable. Aside from that the Syrian bee has many admirable qualities. The Carniolan bees are amiable and produce a very white comb honey but swarm too readily. The Italian bees seem to be preferred by many, while some of the crosses are quite promising. Various hives are discussed and their excellencies and defects pointed out. Handling of bees during brooding, swarming, feeding, doubling, and wintering is considered at greater or less length. The use of chaff hives or chaff-covered hives for winter protection is considered better than removing to a cellar.

The popular objection to bees on the ground that they destroy fruit is shown to rest on a false supposition. It is true that bees suck the juices from fruit when the usual sources of nectar are wanting, but the openings through the skin must be prepared for them by other insects or by cracking, their mouths not being constructed for puncturing.

Among the diseases to which bees are subject the most destructive is that known as "foul brood." This is a contagious disease caused by bacteria. Its presence may be known by the bees becoming languid. Dark, stringy, and elastic masses are found in the bottom of the cells, while the caps are sunken or irregularly punctured. Frequently the disease is accompanied by a peculiar offensive odor. Prompt removal of diseased colonies, their transfer to clean and thoroughly disinfected hives, and feeding on antiseptically treated honey or sirup are the means taken for the prevention and cure of this disease. The antiseptics used are salicylic acid, carbolic acid, or formic acid. Spraying the brood with any one of these remedies in solution and feeding with honey or sirup medicated with them will usually be all that is required by way of treatment. Access to salt water is important for the health of bees. (*Colo. R. 1888, p. 227, R. 1889, p. 80; Mich. B. 8, B. 61, R. 1888, p. 40, R. 1889, p. 100; N. Y. Cornell R. 1888, p. 20; R. I. B. 4, B. 7, B. 9, R. 1889, p. 91, R. 1890, p. 170.*)

Beet (*Beta vulgaris*).—See also *Sugar beet.* The station experiments with beets grown as garden vegetables or as food for stock include tests of varieties, analyses, seed tests, fertilizer tests, and feeding experiments.

VARIETIES.—Tests of varieties are reported as follows: *Ala. Canebrake B. 1; Colo. B. 2, R. 1889, p. 50; Fla. B. 14; La. B. 3, 2d ser.; Me. R. 1890, p. 103; Mass. State R. 1888, p. 147; Mich. B. 46, B. 57, B. 70; Minn. R. 1888, p. 247; Nebr. B. 6; N. Mex. B. 4; N. Y. State R. 1882, p. 121, R. 1883, p. 176; R. 1884, p. 191, R. 1885, p. 114, R. 1889, p. 273; Ohio R. 1882, p. 62, R. 1884, p. 131, R. 1885, p. 113, R. 1886, p. 133, R. 1887, p. 222; Ore. B. 4; Pa. B. 14, R. 1888, p. 142; Utah, B. 3, B. 12; Vt. R. 1888, p. 104, R. 1889, p. 129, R. 1890, p. 151.*

COMPOSITION.—See *Appendix, Table III.*—Analyses are also reported in *Kans. R. 1889, p. 116; Mass. State R. 1888–1891; Minn. R. 1888, p. 103; Vt. R. 1886, pp. 89, 98, R. 1888, p. 75.*

In *Minn. R. 1888, pp. 104, 105,* the feeding values of common and sugar beets and some other roots are shown. In *N. Y. Cornell R. 1890, p. 160,* sugar beets are considered as stock food, their composition and other qualities being compared with those of mangel-wurzels. The latter had the advantage in yield and ease of handling.

SEED TESTS.—Germination tests of beet seed are reported in *Me. R. 1888, p. 140, R. 1889, p. 150; Mich. B. 57; N. Y. State R. 1883, pp. 67, 177; Ohio R. 1886, p. 254; Ore. B. 2; S. C. R. 1888, p. 74; Vt. R. 1889, p. 100.*

FERTILIZER TESTS.—A fertilizer test on Golden Tankard and stock beets is recorded, as also on mangel-wurzels and sugar beets (*Minn. R. 1888, p. 147*). Nitrogen and sometimes potash had a beneficial effect, as also salt, except with the sugar beets. A test on dry, sandy soil at the Florida Station (*B. 14*) showed the benefit of complete fertilizers and especially of the application of salt (see also *Ga. B. 14*).

FEEDING EXPERIMENTS.—See *Silage.*

Beet bacterial disease.—This disease is of recent discovery, and but little is known about its history. It is in no way associated with any of the diseases causing or accompanying the root rot of the beet, as it usually does not cause the death of the plant, any spots on its surface, or discoloration of its tissues. It may usually be recognized by a crinkled, puffed appearance of the leaves, which are smaller than in healthy plants, and die sooner. Upon cutting the root its presence may be known by greater prominence of fibers, a general yellowish color, and less solid texture. The microscope reveals the presence of vast numbers of bacteria in such cases. Selected specimens showed quite a diminution of the percentage of sugar in the diseased plants, sometimes amounting to a loss of 50 per cent. It is probably spread through infected seed and soil. Nothing is known as to treatment or prevention. (*Ind. B. 39.*)

Beet root rot (*Rhizoctonia betæ?*).—This disease, which affects the sugar beet, is quite common in Europe, causing great damage to the larger roots and killing the seedlings. A similar (perhaps the same) disease has appeared in Iowa, where it manifests itself by the gradual dying of the plant. If the root is not fleshy it is rather suddenly destroyed. The leaves of the diseased plants are paler and more or less wilted. It seems to first attack the crown of the root, and gradually the whole root is invaded and the plant killed. Upon pulling up the beets sound ones will come clean from the ground, while affected ones have more or less earth adhering to the diseased parts, the border line of which is marked by a brownish color. It is easily transmitted in the ground, so no crop of beets should follow one where the rot has been the year previous. But little is known as yet as to the effect of fungicides in preventing the disease. (*Iowa B. 15.*)

Beet rust (*Uromyces betæ*).—This rust is quite common in Europe, and has been reported from several localities in this country, where it has caused considerable loss to the market gardeners.

This fungus goes through three phases in its life cycle. The first is passed on the "seed beets," the other two on the regular crop. In the spring the spores, which

have been carried over in the leaves, germinate, forming spores which find their way to their host, the "seed beet." Here another crop of spores is grown, which infests the beet crop with a red rust, causing loss to the gardener. As the first stage seems to be wholly upon the seed beets, its ravages may be held in check by carefully removing all diseased leaves from the seed plants and destroying them. The disease here is shown in small cluster cups on the leaves and should be removed early or the spores may mature and spread.

Spraying with some of the more common solutions would probably prevent the development of the spores where they had found a lodging place. (*Iowa B. 15.*)

Beet rust, white (*Cystopus blitii*).—This may be recognized by the white spots and patches upon the beet leaves.

It may cause considerable damage, but has not been extensively reported as yet. It should yield to the application of some of the common fungicides, though no experiments are mentioned. (*Iowa B. 15.*)

Beet scab (*Oöspora scabies*).—See also *Potato scab.* This disease is now known to be common to the potato and beet, a fact brought out by the independent investigations given in *Conn. State B. 105, R. 1890, p. 81, R. 1891, p. 153; N. Dak. B. 4.* The scab consists of spongy outgrowths of dark-brown color and rough surface and may occur on any part of the root. On the beet the scabs seem to be deeper and larger than on the potato.

The course of the disease may be checked from some cause during the growth of the root, in which case it will be represented by a clearly marked deep scar. The effect that the scab has upon the sugar content of the beet is as yet unknown. The scabbing originates in the soil. The fungus (or its spores) is in the soil, derived from some previous crop, and coming in contact with beet roots produces the scab. It is known that it can remain for several years in the soil and not lose its vitality. Crops of beets and potatoes should not follow each other where the scab is bad. (*Ind. B. 39; Iowa B. 15; N. Dak. B. 4.*)

Beet, spot disease (*Cercospora beticola*).—A fungus disease attacking both the common cultivated beet and the sugar beet. In Europe it is recognized as one of the worst diseases of the sugar beet.

It manifests itself on the leaf by producing small round spots, no larger than a pinhead. Gradually these increase in size, losing to some extent their rounded outline, frequently coalescing. They are of a pale brown color at first, but grow darker with age, until the whole leaf becomes nearly black. The spots are found as frequently on one side of the leaf as on the other and are often so numerous as to soon kill it. When the attack is severe it prevents the growth and maturing of the beet to a considerable degree.

It has been learned that the spores can spend the winter in the old leaves and ground, where they can infest the coming crop, hence all diseased leaves should be removed and burned. In the case of sugar beets it is not definitely known that the percentage of sugar is affected except in the case of smaller and less developed roots. The use of ammoniacal carbonate of copper or Bordeaux mixture is recommended to prevent in a measure its attack.

If the soil is badly infected one crop of beets should not follow another without an interval of one crop or more. (*Iowa B. 15; Mass R., 1889, p. 225.*)

Beet water core.—Various well-defined spots are often noted in roots of sugar-beets, having a watery appearance, similar to the water core of apples. The spots are of various sizes, colorless, and sharply defined, and occur between the fibrous rings. There seems so far to be no parasite present and the cause of the water cores is unknown. (*Ind. B. 39.*)

Beggar weed (*Desmodium molle*).—A leguminous plant, which is a promising hay plant for Florida and for poor sandy land along the Gulf coast. At the North Louisiana Station it grows 5 or 6 feet high. Cows and sheep are said to be very

fond of it. Analyses made at the Florida Station indicate that it has a high nutritive value. "Beggar weed will make two crops of hay. The second crop * * * is regarded by some as the very best of hay." (*Fla. B. 11; La. B. 8, 2d ser.*)

Beimling milk test.—See *Milk tests.*

Bent grasses.—See *Grasses.*

Berkshire pigs.—See *Pigs, breeds.*

Bermuda grass.—See *Grasses.*

Berrigan separator.—See *Creaming of milk, separating.*

Big head of horses.—See *Actinomycosis.*

Big jaw of cattle.—See *Actinomycosis.*

Birch trees (*Betula* spp.).—Two native birches, the black and the cherry (*B. nigra* and *B. lenta*), are briefly noted in *Ala. College B. 3.* Three species are catalogued (*Nebr. B. 18*) as native in Nebraska, and various species, especially the European white (*B. alba*) and the yellow (*B. lutea*), are noted in *S. Dak. B. 12, B. 15, B. 20, B. 23, R. 1888, p. 22.* The birches as tested at that station have suffered seriously from drought, leaving their ultimate success considerably in doubt.

Several birches are characterized in *Minn. B. 24,* where the "canoe, silver, or white" birch (*B. papyracea*) is commended as a beautiful lawn and park tree, not planted nearly as much as it should be. The European white and the cut-leaved (here considered as a variety of the former), also a purple-leaved variety, are regarded as very desirable for ornament. In *Iowa B. 16* the cut-leaved birch (here classed as *B. amurensis,* var.) is recommended as "proving an ironclad and a thing of beauty on all soils and in all parts of the Northwest so far as heard from." American and foreign birches are included in the tree lists of several other stations.

Blackberry.—The blackberries cultivated in America are the varieties of *Rubus villosus,* though the name sometimes includes the dewberry, *Rubus canadensis* (see *Dewberry*). The work of the stations has been chiefly the testing of varieties with reference mainly to hardiness and the quantity and quality of the fruit, and the study of its diseases. Tests of varieties are reported as follows: *Cal. R. 1888–'89, pp. 88, 110; Colo. R. 1890, p. 34; Del. R. 1889, p. 103; Ga. B. 11, B. 15; Ill. R. 1888, p. 11; Ind. B. 5, B. 10, B. 31, B. 33, B. 38; La. B. 26; Me. R. 1889, p. 256; Mass. Hatch B. 7, B. 10, B. 15; Mich. B. 55, B. 67, B. 80; Minn. R. 1886, p. 61, R. 1888, pp. 235, 285, R. 1890, p. 27; Mo. B. 10, B. 13; N. Y. State B. 36, n. ser., R. 1885, p. 229, R. 1886, p. 256, R. 1887, pp. 337, 338, R. 1888, pp. 96, 100, R. 1889, pp. 311, 312, R. 1890, pp. 281, 282, N. C. B. 72, B. 74; N. Dak. B. 2; Ohio B. vol. II, 4, B. vol. IV, R. 1888, pp. 114, 115, 6; Pa. B. 18; R. I. B. 7; Tenn. R. 1888, p. 12; Tex. B. 8; Vt. R. 1888, p. 117, R. 1889, p. 122; Va. B. 2.*

Notes on the culture of blackberries are given in *Ga. B. 15,* and *N. Dak. B. 2.* A fertilizer experiment is recorded (*Mass. Hatch R. 1888, p. 43*). In *N. Y. Cornell B. 25* it is mentioned that according to many tests pollinations between blackberries, raspberries, and dewberries produce no effect the first year.

Blackberry anthracnose.—See *Anthracnose of blackberry.*

Blackberry cane borer (*Oberea bimaculata*).—The grub of this species is yellowish in color and about three-fourths of an inch long. The adult is a small, slim, black beetle. The female lays her eggs in June near the tip of the growing stem of the blackberry or raspberry plant. When the egg hatches the grub bores its way downward through the cane, coming to the surface occasionally. If unchecked it will reach the roots by fall and spend the winter in the ground, appearing the following season as a beetle. When depositing her eggs the female girdles the stem twice at points about one-half inch apart near the tip and lays an egg between these rings. The sudden wilting of the tips will indicate the presence of the egg or young grub, and the cane should be cut at the lower ring and burned. If this is not done soon after the egg is deposited the whole cane should be burned. (*N. Y. Cornell B. 24; Ohio R. 1888, p. 154; N. Y. State B. 35.*)

Blackleg [also called *Black quarter*].—An infectious disease of cattle, due to a specific germ called *Bacterium chauvei.* It is usually fatal, running its course in a few hours to several days.

It is very much like anthrax, but in several respects differs from that disease. The characteristic symptoms are lameness, fever, and swellings on the legs above the knee, sometimes on the neck or back. If the hand be passed over these swellings a crackling sound will be heard, due to gas formed under the skin. In blackleg the spleen and liver are not enlarged nor changed in any way and the blood does not lose its ability to coagulate, as in the case of anthrax. In the latter disease no crackling sound is given from any of the swellings caused by it. Blackleg seems to be confined to certain low-lying grassy situations and the germs of infection seem to be derived from such pastures. When the attack is severe death almost always results. In the milder attacks (especially on valuable animals) if taken in time the administration of epsom salts, one-quarter to one pound, if the bowels of the animal are not loose, followed by dram doses of quinine four or five times a day, may give relief. Preventive inoculation, however, is the best means to employ in regions where the disease is common and liable to recur. By this means a mild attack is caused and immunity from subsequent attacks secured. This disease is preëminently one of cattle, but sheep are also said to be susceptible to its infection. (*Mo. B. 12; S. Dak. B. 25.*)

Black quarter.—See *Blackleg.*

Black walnut.—See *Walnut.*

Blister beetles (*Epicauta* spp.).—There are several kinds of these beetles, known as black, gray, one-colored, spotted, and striped blister beetles, their colors giving them their individual names. They get the name blister beetle from their property of producing blisters on the skin when roughly handled. One of the best-known species is the striped blister beetle or the "old-fashioned potato bug." They are all rather long soft-bodied insects that feed in droves, and when abundant quickly destroy great quantities of plants. Their larvæ are especially destructive to the eggs and young grasshoppers of Rocky Mountain locusts and where these are abundant the beetles may be expected. They may usually be driven off by whipping the infested plants or by catching in vessels by hand. Spraying with arsenites whatever plants they may be feeding on will kill them. (*Iowa B. 15; Minn. B. 8; Nebr. B. 14, B. 16.*)

Blood, dried.—See *Appendix, Table IV.*

Blue grasses.—See *Grasses.*

Blue joint.—See *Grasses.*

Blue thistle.—See *Weeds.*

Bokhara clover.—See *Melilotus.*

Bollworm (*Heliothis armigera*).—The larva of this species is 1 to 2 inches long, and varies from pale green to dark brown in color, with light stripes along the sides. The adult is a dusky yellow moth, the fore wings of which have a broad, dark margin, with a row of small dark dots. The hind wings are similarly marked, but of lighter color. The moth measures an inch and a half across its expanded wings. The larva feeds upon quite a number of plants, being especially fond of corn, cotton, tomatoes, tobacco, and melons. On account of the number of plants upon which it may feed, it is difficult to destroy. There are usually two broods each season.

Fall plowing will aid in destroying the bollworm. Where insecticides can be used arsenites, white hellebore, and pyrethrum may be employed to advantage. In the cotton belt planting corn with cotton is tried as a protection for the cotton, the bollworm preferring the corn. Unless the crops are properly proportioned the worms are liable to exhaust the corn, and then turn on the cotton in added numbers. The corn should be cut and fed, so as to prevent the transformation of the worms into moths

(*Ark. R. 1889, p. 146, R. 1890, p. 73; Fla. B. 9; Ky. R. 1889, p. 9; N. J. R. 1890, p. 516; N. C. B., 78.*)

Boneblack.—The carbonaceous residue resulting from the calcination of bones in closed vessels. It is used for clarifying or defecating solutions, especially sirups, as a black pigment, and as a fertilizer either directly or after conversion to superphosphate by treatment with sulphuric acid. In the latter case it is usually known as dissolved boneblack. For composition see *Appendix, Table IV.* (*Conn. State R. 1881, p. 67.*)

Bones.—Bones of animals, which have long been used as a fertilizer. are composed principally of phosphate of lime and gelatinous matter rich in nitrogen. They are therefore a nitrogenous as well as a phosphatic fertilizer. For composition see *Appendix, Table IV.* The phosphate in bone is in the tri-calcic or insoluble form. If, however, the bone is finely ground it rapidly decomposes in the soil and readily yields both its nitrogen and phosphoric acid to plants. The necessity for a good mechanical condition has led to the common practice of grading commercial bone and valuing it according to its fineness. The phosphoric acid in fine bone (smaller than one-fiftieth inch) is at present valued at about 7 cents per pound, while that in coarse bone (larger than one-twelfth inch) is valued at only 3 cents per pound (see also *Fertilizers, valuation*).

"The terms bone dust, ground bone, bone meal, and bone applied to fertilizers, sometimes signify material made from dry, clean, and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease; and if taken from garbage heaps, with ashes or soil adhering; again they denote mixtures of bone, blood, meat, and other slaughterhouse refuse which have been cooked in steam tanks in order to recover grease, and are then dried and sometimes sold as tankage; or finally, they apply to bone from which a large share of the nitrogen has been extracted in glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value." (*Conn. State R. 1890, p. 28.*)

Bones mixed with meat scrap, blood, or other slaughterhouse refuse (tankage) are richer in nitrogen and poorer in phosphoric acid than pure bone, while the products from bones which have been subjected to rendering for glue are poor in nitrogen and rich in phosphoric acid.

The Pennsylvania Station has studied the difference in composition of particles of bone of different degrees of fineness (*Pa. R. 1889, p. 190*). Samples of bone were separated into four different grades by means of sieves and each grade was analyzed separately. It was found in general that the percentage of both phosphoric acid and nitrogen increased with the coarseness of the particles, but "for the purpose of valuation any bone may be assumed to be identical in composition in all its grades of fineness." The Connecticut State Station (*R. 1887, p. 91*) has reached a similar conclusion.

For methods of composting see *Ashes and Composts.* For field trials in comparison with other phosphates see *Phosphates.*

(*Conn. State R. 1887, p. 91; Mass. State R. 1891, p. 309; N. J. B. 74, R. 1890, p. 91; N. C. B. 61, R. 1881, p. 68; Pa. R. 1889, p. 190.*)

Bordeaux mixture.—See *Fungicides.*

Borecole.—See *Kale.*

Botany.—Under this head are included the scientific investigations on plants, as distinguished from the more practical work in agriculture and horticulture. The work in botany may be classified in three divisions—systematic, structural, and physiological. Systematic botany includes the collection and classification of plants; structural botany has to do with their structure; physiological botany relates to the processes of their development. In many of the States, particularly in the South and West, so little work in systematic botany has been done that it is important for the

stations to make collections of the native plants with a view to finding out which of these are likely to be of use or injury to the farmer. The work on grasses done by the Colorado, Mississippi, North Carolina, and Tennessee Stations, and that on weeds by the California, New Jersey, and West Virginia Stations are examples of useful work in systematic botany. Comparatively little work in structural and physiological botany has as yet been done by the stations, except that in connection with investigations of the diseases of plants. Relatively expensive apparatus and specially trained workers are required for successful investigations in these lines. Among the stations which are well equipped for this kind of work are the Indiana, Massachusetts State, and New York Cornell Stations. An officer with the title of botanist is employed at 27 stations.

Botfly of oxen (*Hypoderma bovis*).—The fly is about one-half inch long, black, and thickly covered with fine yellowish hairs. The front of the head is dirty ashen, the wings smoky-colored and the naked black thorax (or body) twice broadly banded with yellow and white. From June to September the flies lay their eggs on the backs of cattle, and it is generally stated that when the eggs hatch the grubs bore beneath the skin of the animal and live there during the winter and spring. It has been claimed, however, that the grubs get into the œsophagus by the animals licking themselves, thence bore their way out and appear under the skin in a short time (Curtice). The presence of the bot is made evident by the appearance of lumps of varying size along the animals' backs. These are usually called "warbles," or in some places "wolves" and "wormals." Upon reaching full size the grub comes out, tail first, and falls to the ground, where it buries itself, soon to come out a full-fledged fly. Great damage is done both to the hides and flesh of animals by warbles and the annual loss is considerable.

One form of preventive treatment consists in coating the backs of cattle with kerosene, train oil, or fish oil, thus preventing the laying of the eggs. Better methods are to squeeze the grubs out of the warbles and destroy them, or to smear over the warbles with grease in which sulphur is mixed, or with any thick greasy matter which will choke the breathing pores of the bot. (*Ky. R. 1889, p. 21, B. 40; Miss. B. 14; Ohio B. vol. III, 4.*)

Botfly of horses (*Gastrophilus equi*).—The horse botfly in its perfect state is pale yellowish, spotted with red, with grayish-yellow hairs. The thorax (or body) is usually banded with black hairs. The wings are banded with red. The flies appear from June to October, and deposit their eggs (commonly known as "nits") on the horses, usually where the animal can reach them with his tongue or lips, and, by biting or licking, the nits obtain access through the mouth to the stomach. The larvæ hatch out and when mature hang by their mouth hooks on the edge of the rectum, whence they are carried out in the excrement, and complete their transformation into flies on the ground. The use of medicinal agents to destroy or expel bots is as a rule unsatisfactory. The most rational treatment is care of the general health and condition of the animal; thorough grooming and cleanliness to destroy nits, and stimulation of appetite and digestion by tonics such as gentian, ginger, cinchona bark, etc., given either in food or as drenches. (*La. B. 15, 2d ser.*)

Box elder (*Acer negundo* [*Negundo aceroides*]).—This tree has been much planted on the Western prairies for shade, protection, etc., notwithstanding its small size, low trunk, and inferior wood. It is easily obtained and propagated, grows rapidly when young, and has a dense foliage. When planted in groves its dense leaf canopy soon suppresses vegetation beneath and takes away the necessity for further culture (*S. Dak. B. 20*). It is better fitted for a nurse tree for other species than any other native tree (*S. Dak. B. 23*). (*Cal. R. 1880, p. 68, R. 1890, p. 236; Nebr. B. 18; S. Dak. B. 12, B. 15, B. 20, B. 23, R. 1888, p. 22, R. 1889, p. 35.*)

Bran.—For composition see *Appendix, Tables I and II,* under *Cockle, Rice, Rye, Wheat.* See also *Wheat bran.*

Brazilian flour corn.—See also *Corn.* A small and delicate variety of maize, prolific in suckers, and producing an abundance of leaves. The kernels are soft and easily destroyed by weevils. They make a white meal resembling wheat flour. To mature corn it requires a warm climate. At the Michigan, New York Cornell, Ohio, and Pennsylvania Stations it did not ripen, and was inferior to other varieties of corn as a forage crop (*Mich. B. 47; N. Y. Cornell B. 16; Ohio B. vol. III, 3; Pa. B. 6, R. 1888, p. 45*). At the Kansas Station in the favorable season of 1891 it tasseled July 31 and was ripe September 15. The stalk was 10 feet high and the ear 5 feet above the ground. It yielded 65 bushels of corn, while the best yields of other kinds of corn that year at the same station were from 80 to 90 bushels. In 1889 it yielded green forage at the rate of 17 tons per acre. In 1888 and 1890 the size of the plant and the yield of forage were materially reduced by drought (*Kans. B. 18, B. 30, R. 1889, p. 50*). At the Alabama Canebrake Station (*B. 7*) Brazilian flour corn yielded 25 to 30 bushels of corn per acre. At the Georgia Station it yielded from 8 to 12 tons of green forage and 3 to 3½ tons of dry fodder per acre (*Ga. B. 12, B. 13, B. 17*).

COMPOSITION.—The following analyses are from *Ga. B. 13:*

	Water.	Ash.	In dry matter.			
			Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kernels	13.28	3.26	12.55	2.26	79.06	2.87
Cob	11.25	10.87	1.66	41.59	44.87	1.01
Stover	34.62	6.11	6.38	29.42	56.33	1.76

The ear taken for analysis weighed 567 grains, the kernels 446.51 grains, and the cob 120.49 grains; percentage of kernels 78.75, of cob 21.25.

Breeding.—Information regarding the breeding of domestic animals has been published by the stations as follows: Milch cows, *Ala. College B. 24, n. ser.;* Pigs, *Minn. B. 14.*

Breeds.—See *Cows* and *Pigs.*

Brewers' grains.—See *Feeding farm animals.* For composition of wet and dry grains and of silage see *Appendix, Tables I and II.*

Broccoli.—This is a vegetable of the cabbage group, closely resembling the cauliflower, in which the young flower-cluster is converted into a low, fleshy head surrounded with leaves. From 1 to 10 varieties were planted at the New York State Station each year for four years (*R. 1882, p. 133, R. 1883, p. 188, R. 1884, p. 213, R. 1885, p. 132*). As grown in 1883 it differed from the cauliflower chiefly in being more hardy and rather less delicate in flavor. In 1885 it was judged to have little value for the New York climate.

Germination tests of broccoli seed are reported in *N. Y. State R. 1883, pp. 67, 270; Ohio R. 1884, p 197; Ore. B. 2; Vt. R. 1889, p. 101.*

Brome grasses.—See *Grasses.*

Broom corn (*Sorghum vulgare* var.).—A tall reed-like grass (variety of non-saccharine sorghum), growing to a height of 8 or 10 feet. Its branched panicles are made into brooms and brushes. But few experiments with broom corn have been made at the stations. In 1887 the Colorado State College (*B. 2*) reported that after several years' experiments with 6 varieties, Evergreen was selected as the best for improvement. Careful selection of seed of this variety made it much better, the brush becoming longer, finer, straighter, and brighter in color. The improved plants were also healthier. At the Nebraska Station (*B. 19*) broom corn was planted May 1 in hills 3 by 4 feet apart, 2 to 6 grains in a hill, plowed three times and hoed

twice. Both varieties grown, Wilson Evergreen and Tennessee, were of extra fine quality. Broom corn did fairly well at the Nevada Station (*R. 1891, p. 16*).

Broom rape.—See *Weeds.*

Brussels sprouts.—A form of the cabbage in which numerous small heads are developed along the stump from the axils of the leaves instead of a terminal head. A plantation of this vegetable is noted in *N. Y. State R. 1882, p. 133.* Germination tests of its seed are recorded in *N. Y. State R. 1883, pp. 67, 261; Ore. B. 2; Vt. R. 1889, p. 101.*

Buckeye trees (*Æsculus*, sp.).—*Esculus pavia* of the South is noted in *Ala. College B. 3, n. ser.*, as ornamental, but of poor quality as wood.

Buckthorn (*Bumelia lanuginosa*).—A small tree with hard wood, somewhat useful for hedges and in other ways, is described under this name in *Ala. College B. 3, n. ser.*

Buckwheat (*Fagopyrum esculentum*).—The work of the stations on this grain has been confined to a few tests of varieties and analyses. The Japanese buckwheat, introduced in recent years, has been found generally preferable to the common varieties. Its flowers furnish excellent food for bees (see *Bee plants*).

COMPOSITION.—See *Appendix, Tables I and II.* See, also, *Mass. State R. 1890, p. 181; N. J. B. 87;* and for Japanese buckwheat, *Vt. R. 1888, p. 74* (at five stages of growth), *Vt. R. 1889, p. 89.* At Connecticut Storrs Station (*R. 1888, p. 31*) it was found that the roots and stubble of buckwheat, to a depth of 1 foot, calculated in pounds per acre, contained dry matter 483, nitrogen 4.4, phosphoric acid 1.3, potash 3.8.

(*Colo. R. 1888, p. 37, R. 1889, p. 6, R. 1890, p. 11; Iowa B. 7; La. B. 22, B. 8, 2d ser.; Mich. R. 1889, pp. 99, 182, 270; Minn. B. 11; Nev. R. 1891, p. 16; Ore B. 4; Vt. R. 1888, p. 73, R. 1889, p. 85.*)

Buckwheat mildew (*Ramularia rufomaculans?*).—A fungous disease recently observed upon buckwheat, where it does considerable damage. It attacks the lower leaves and spreading upwards stunts the growth of the plant, impairing the quality and diminishlng the quantity of the seed.

Burning of the stubble and refuse and rotation of crops seems the best way to prevent its ravages. As it grows upon other members of the buckwheat family (*Polygonaceæ*) all smartweeds and wild buckwheats should be looked after to prevent infection from them. (*Conn. State R. 1890, p. 98.*)

Bud moth (*Tmetocera ocellana*).—This moth is of an ashy gray color, with some darker markings, and is one-half to three-fourths of an inch across its wings. It lays its eggs in the summer. These soon hatch and the small caterpillar feeds on the leaves under a web which it weaves and in which it spends the winter. In the spring it finds its way to the leaves and flower buds of the apple, plum, blackberry, and other hosts. It destroys the bud by eating out the center, and thus often interferes very seriously with the plant's growth.

This pest may be destroyed by gathering and burning the leaves in the fall and spraying trees and bushes with Paris green, 1 pound to 150 gallons of water, just before the buds begin to swell and after they open.

The life history of this insect is given, so far as known, in *Mass. Hatch B. 12; Me. R. 1888, p. 169, R. 1890, p. 128.* The former contains a report of original investigations of considerable value.

Buffalo berry (*Shepherdia argentea*).—Notes on this shrub are made in *Minn. B. 18*, with reference to its cultivation for fruit. Attempts hitherto have failed in consequence, as believed, of its being diœcious. As described, it is a pretty ornamental shrub, not suitable for hedges, slow of growth, prolific, and highly prized for its fruit in the drier portions of the Northwest; the fruit is small, quite acid, scarlet in color, containing small seed. The buffalo berry is noted in *Nebr. B. 18* as the only one of the shrubs and trees from the Rocky Mountains which has spread over the entire State.

Buffalo grass.—See *Grasses.*

Bugloss.—See *Weeds.*

Buhach.—See *Pyrethrum.*

Buildings.—See *Farm buildings.*

Bunt.—See *Wheat, stinking smut.*

Bur clover (*Medicago maculata*).—An annual forage plant, sometimes called California clover, which is a native of a warm climate. It throws out long, slender, vine-like runners, and bears its seed inside of spirally coiled pods drawn together like a bur. It is a winter-growing plant, affording early spring pasturage in the South. It seeds in May and from the seed a new growth springs up early in the fall. It may be sown on Bermuda grass sod, and the two plants will afford almost continuous pasturage (*Miss. B. 20; N. C. B. 73*). The seed is expensive. From 2 to 5 bushels of the burs or 20 pounds of clean seed are sown to the acre (*N. C. B. 73*). If not too closely pastured it reseeds itself. At first animals refuse it but soon learn to relish it. The burs, in which the seeds are contained, may get into the wool of sheep and prove troublesome. (*Cal. R. 1890, p. 242; La R. 1891, p. 11; Miss. B. 20, R. 1889, p. 32; Nebr. B. 6; N. C. B. 63, B. 73.*)

Burdock.—See *Weeds.*

Bur grass.—See *Weeds.*

Butter.—See also *Butter-making.*

COMPOSITION.—For average composition see *Dairy products.* For composition of sweet-cream butter see *Butter from sweet and sour cream.* (*Ala. College B. 25, n. ser.; Ark. R. 1889, p. 5; Conn. State R. 1888, p. 105, R. 1891, p. 122, B. 106; Ill. B. 9; Iowa R. 1890, p. 501; Kans. R. 1888, p. 161; Mass. State R. 1890, p. 311; Miss. R. 1890, p. 40; N. H. B. 13, R. 1888, p. 54; N. Y. State R. 1887, p. 372, R. 1891, p. 307; Tex. B. 11; Vt. R. 1888, p. 19; W. Va. R. 1890, p. 29; Wis. R. 1885, p. 43, R. 1888, p. 136.*

Butter extractor [also called Extractor-separator].—An apparatus designed to make butter directly from sweet whole milk, and essentially a separator and a continuous churn combined. The time required for creaming and churning any particular drop of milk is probably not over a second. The butter made is of course sweet-cream butter. The Delaware Station (*B. 9*) has made the most thorough study of the efficiency of this machine. It was found to give a smaller yield of butter from a given amount of milk fat than the ordinary methods, part of this deficiency being due to churning the cream sweet. The mechanical loss was larger than in making sweet-cream butter by ordinary means. Comparisons of the extractor with the sweet-cream and sour-cream processes, raising the cream by separator, showed it to give 3.80 per cent less butter than the sweet-cream process and 8.75 per cent less than the sour-cream process.

The quality of the butter from the extractor was about the same as that of sweet-cream butter made by ordinary methods. (See *Butter from sweet and sour cream.*)

Tests of this machine have also been reported in *Vt. B. 27* and *Pa. B. 22.*

Butter from colostrum.—See *Colostrum.*

Butter from sweet and sour cream.—For yield of butter from sweet and sour cream see *Churning.*

It is generally agreed that the flavor of sweet-cream butter is somewhat different from that of sour-cream butter, and that while most persons might learn to like it, some object to it at first. At the New Hampshire Station (*R. 1888, p. 62*) the sweet-cream butter was believed to be of superior grain to that from sour cream, owing to the lower temperature at which it was churned. This was also true in tests at New York State Station (*R. 1889, p. 207*). In the tests at the Texas Station those who tasted the sweet-cream and sour-cream butters without knowing their nature rated the sweet-cream butter slightly higher. The grain and body of the latter butter was also rated a little higher. The Delaware Station (*B. 9*) found the sweet-

cream butter lacking in firmness. At the Illinois Station (*B. 9*) the butter from strongly acid cream was rated of better quality than that from barely ripened cream.

Comparative analyses of butter from sweet and sour cream have shown that in general sweet-cream butter contains rather less water and curd (casein) than sour-cream butter (*Del. B. 9; N. H. R. 1888, p. 63; N. Y. State R. 1889, p. 207; Wis. R. 1888, p. 113*). This would suggest a rather better keeping quality for the former. The only observations reported on the keeping quality of sweet and sour-cream butter are by the Iowa Station (*B. 8, B. 11*). Both butters were made December 14, 1889, at a creamery in Iowa. Until June 20, 1890, the two tubs were kept together in a cellar without ice, being examined about once a month; later they were placed in an ice chest, where they were kept to the close of the trial, August 20. The author sums up the results in the following words: "There was no marked difference in the keeping quality of the two butters; what difference there was was in favor of the sweet-cream product. As to flavor, for the first two or three months most of the tasters preferred the ripened-cream butter, declaring that made from sweet cream to be comparatively 'flat,' 'insipid,' or 'flavorless'; but the longer the butters were kept, even while both were still sweet, the less marked became the difference between them in this respect." (See also *Butter-making* and *Milk fermentations.*)

Butter-making.—Under this head will be discussed (1) the losses of fat in butter-making, (2) distribution of ingredients in butter-making, (3) the effect of food on churnability of the fat, (4) effect of food on the quality of the butter, (5) effect of ripening cream. References will be given to other points not discussed.

For cream-raising by different methods see *Creaming of milk.* For churning see *Churning.* For extractors, etc., see *Dairy apparatus.* For effect of food on yield of butter see *Milk, effect of food.* For cost of making butter from the milk of different breeds see *Cows, tests of dairy breeds.*

Losses of fat in butter-making.—The principal sources of loss of fat in the process of butter-making are the skim milk, the buttermilk, and washings, and mechanical losses from butter sticking to the vessels and implements. A certain amount of loss is unavoidable, but "the variation in the amount of fat recovered may make all the difference between a paying and a losing business." As a rule the loss is greater when the fat globules are small than when relatively large, as the smaller globules separate more difficultly in creaming and in churning (See *Milk* and *Creaming of milk*). Careless methods in butter-making may result in very heavy losses. It was stated by one of the stations several years ago that there were probably few dairies or creameries where the loss of fat was less than 10 per cent of the total amount in the milk and that in private dairies the loss might be 30–35 per cent. The Vermont Station (*R. 1888, p. 145*) found by actual tests at several creameries in that State during the summer that in nearly every case there was a loss of 1 pound of butter fat for every 10 pounds saved. The same station found (*R. 1891, p. 70*) in a more recent study at one creamery where the milk was creamed by a separator, that the average loss of fat in the skim milk and buttermilk was 7.5 pounds for each 100 pounds of fat in the whole milk, or 7.5 per cent. The station believes that this can be improved upon. It calculates the distribution of the fat in butter-making, with a loss of 8 per cent, as follows:

	Pounds.
Fat in 1,000 pounds whole milk	40.0
Fat in 800 pounds skim milk	2.4
Fat in 187 pounds buttermilk	0.8
Fat recovered in 43.3 pounds butter	36.8
	40.0

The Delaware Station (*R. 1889, p. 164*) found in a single day's test at a creamery where the milk was creamed by a separator that 6 per cent of the total fat of the milk was lost in butter-making, 3.17 per cent being lost in the skim milk, 0.7 per

cent in the buttermilk, and the remaining 2.13 per cent through mechanical and other losses.

The Wisconsin Station (*R. 1885, p. 139*) has determined the losses where the cream was raised by deep setting as follows:

	Pounds.
Fat lost in skim milk	12.48
Fat lost in buttermilk	13.43
Fat recovered in butter	74.09
	100.00

That is, for each 100 pounds of fat in the whole milk there was lost in the skim milk and buttermilk 25.91 pounds of fat, or one-quarter the total amount. These losses are believed to be higher than usually occur in careful management.

There are undoubtedly breed and individual characteristics which affect the thoroughness of the recovery of fat in butter-making. The Maine Station (*R. 1890, p. 17*) has calculated the actual losses of fat in skim milk and buttermilk in the case of different breeds and individuals. The following are the average percentages of total fat lost in buttermilk and skim milk during two years:

	Per cent.
Holstein No. 1	10.3
Holstein No. 2	16.4
Ayrshire No. 1	13.7
Ayrshire No. 2	26.3
Jersey No. 1	3.5
Jersey No. 2	7.1

The New York State Station (*R. 1891, p. 307*) reports average results in the same line, with cows of different breeds. During one period of lactation the percentage of the total fat in the whole milk which was lost in butter-making was as follows:

	Per cent.
Guernseys	9.0
Jerseys	10.1
American Holdernesses	16.4
Devons	17.7
Ayrshires	20.9
Holsteins	25.4

In both of the above experiments the milk from the different cows or breeds was all treated alike, being creamed in cold deep setting. The New York State Station says, in commenting on the results: "The question arises as to the best method of getting the fat of the Holsteins from the milk to the butter without such serious loss. This can be accomplished satisfactorily by using a centrifugal machine for separating the milk."

(*Ala. College B. 7; Conn. State R. 1891, p. 120; Del. B. 9; Me. R. 1890, p. 43; N. H. R. 1888, p. 54; N. Y. State R. 1883, p. 113; Tex. B. 14; W. Va. R. 1890, p. 29, B. 6; Vt. B. 16, R. 1890, p. 92; Wis. R. 1885, p. 122, R. 1888, p. 51.*)

DISTRIBUTION OF INGREDIENTS IN BUTTER-MAKING.—The Vermont Station (*R. 1891, p. 119*) has calculated the average distribution of milk and fertilizing ingredients in making butter from 1,000 pounds of milk as follows:

Distribution of milk ingredients in butter-making.

	Total solids.	Fat.	Casein.	Albumen.	Milk sugar.	Ash.	Proportion of the total milk fat found in the product.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
1,000 pounds of whole milk	130.0	40.0	26.0	7.0	49.5	7.5	....
800 pounds of skim milk	78.0	2.4	22.0	6.0	41.2	6.4	6
200 pounds of cream	52.0	37.6	4.0	1.0	8.3	1.1	94
187 pounds of buttermilk	14.91	0.8	3.77	0.9	8.3	1.1	2
43.3 pounds of butter	37.09	36.8	0.23	0.06	....	....	92

Distribution of fertilizing ingredients.

	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*
1,000 pounds of whole milk	5.3	1.9	1.75
800 pounds of skim milk	4.5	1.6	1.50
200 pounds of cream	0.8	0.3	0.25
187 pounds of buttermilk	0.75	0.27	0.24
43.3 pounds of butter	0.05	0.03	0.01

It will be seen that a very large proportion of the valuable fertilizing ingredients remain in the skim milk, and a much smaller proportion in the buttermilk, so that the butter contains only a trace of these ingredients. Valuing the fertilizing ingredients at the average prices for these ingredients in commercial fertilizers, "the total fertilizing value of the milk for a year from a dairy of twenty cows giving 4,000 pounds of milk apiece will approximate $86.80, all of which is lost to the farm if the whole milk is sold, one-sixth ($13.20) if butter is sold and the buttermilk left at the factory, and one-hundredth ($0.86) only if butter is sold and both skim milk and buttermilk fed upon the farm." (See also *Wis. R. 1885, p. 139.*)

EFFECT OF FOOD ON CHURNABILITY.—By churnability is meant the proportion of fat in the milk which is recovered in the butter—not merely the proportion of fat in the cream which is recovered by the churn, but the fat recovered from the milk by the two processes of creaming and churning. The character of the food has been supposed to have an influence on churnability, and the work of some of the stations bearing on the point is here given. Earlier experiments at the Wisconsin Station (*R. 1888, p. 51*), at Houghton Farm, by Prof. H. E. Alvord (*Proc. Soc. for Prom. of Agr'l Science, 1883–'84, pp. 23, 24*), and at the New York State Station (*R. 1883, p. 95*), indicated that succulent foods, as silage and grass, improved the churnability. Later experiments at the Wisconsin Station (*R. 1889, pp. 92, 116, R. 1890, p. 80*) have not confirmed the earlier observations, and point to the conclusion that "succulent foods do not change the character of the milk so as to cause its fat to be more readily recovered in the butter." The Maine Station concluded (*R. 1889, p. 130*) that if there was any difference between the effects of dry food and silage on churnability "it was so small as to be obscured by other influences." The Vermont Station (*R. 1890, p. 70*) sums up the results of its trials bearing on this question with the statement that "if

there is any difference in churnability on account of food it is in favor of dry food. A trial at the New Hampshire Station (*B. 13*) of hay *vs.* silage gave conflicting results as to effect on churnability. In the light of these experiments and those made elsewhere it seems extremely doubtful if succulent foods actually increase the thoroughness with which the milk fat may be recovered in the butter.

The New York State Station (*R. 1883, p. 115*) noticed that gluten meal seemed to decrease the churnability and bran to increase it. Thus, when hay and bran, with or without corn meal, were fed, from 95.66 to 98.4 per cent of the total fat of the milk was recovered in the butter, and when hay and gluten meal were fed only 74.73 per cent was recovered. An experiment at the New Hampshire Station (*B. 13*) pointed in the same direction, indicating that the feeding of gluten meal tended to decrease the churnability of the fat as compared with corn meal or cotton-seed meal.

The Texas Station (*B. 14*) studied the effect on the creaming of milk of cotton-seed and cotton-seed meal as compared with corn-and-cob meal, using cows in different stages of the milking period. It was found that in deep setting at either 70° or at 45° F. (ice water) the milk from the cotton seed and cotton-seed meal feeding creamed more completely than that from corn-and-cob meal, that there was practically no difference between cotton seed and cotton-seed meal in this respect, and that in centrifugal creaming there was no difference due to food.

At the Vermont Station (*R. 1890, p. 88*) the results of a comparison of mixtures of bran with buckwheat middlings, and corn meal with cotton-seed meal and linseed meal "add testimony to the belief that milk from such foods creams less thoroughly than that from heavier meal." In another trial at the same station "the milk creamed less successfully on bran and rye than on any other feed." The Kansas Station (*R. 1888, p. 95*) found that ground oats added to a ration invariably improved the churnability of the fat.

(*Me. R. 1889, p. 106; Pa. B. 17; N. Y. State R. 1889, p. 92.*)

Effect of food on quality of butter.—The New York State Station (*R. 1889, p. 117*) in summarizing the results of experiments for two years reports that "the character of the food did largely influence both the yield and the quality of butter." The butter made on linseed meal was too soft. Oats gave the best colored and the hardest butter, but it was rather crumbly. With reference to the effect of cotton seed and cotton-seed meal on the character of butter, several experiments have been made in this country which are of interest, showing that the melting point of butter was higher and the percentage of volatile fatty acids lower with cotton seed or cotton-seed meal than without it, *i. e.*, that a firmer, harder butter was produced when these foods were fed. This observation was first made by the Texas Station (*B. 11*), and was confirmed by experiments by the U. S. Department of Agriculture in coöperation with the Maryland Station (*Proc. Socy. Prom. Agr'l Science, 1889*), and at the Alabama College Station (*B. 25, n. ser.*). In the latter case the melting point of the butter increased 12° to 14° F. when cotton seed or cotton-seed meal was fed. In trials at the Pennsylvania Station (*B. 17*) the melting point only was determined, but this was from 3° to 9° F. higher on the cotton-seed meal ration than on the bran ration. The melting point on the former ration ranged from 96° to 102° and averaged 99°; on the bran ration it ranged from 91° to 97° and averaged 93°.

In the trials at the Texas and Pennsylvania Stations samples of the butters were submitted to a board of judges to be rated. In all cases the butter produced on cotton seed or cotton-seed meal was rated considerably lower than that made on rations without these foods. In Texas it was stated that these foods affected the texture of the butter in a similar way to overworking, and gave a colorless butter.

At the New Hampshire Station comparisons of butters made on gluten meal, corn meal, cotton-seed meal, or skim milk, with a basal ration, showed the butter on the gluten-meal ration to be softer than any of the others. It was also found that silage produced a somewhat softer butter than hay. "The iodine absorption of butter from gluten-meal rations was greater than that of butter from cotton-seed or corn-meal rations." (*N. Y. State R. 1888, p. 292.*)

There seems, then, little doubt that certain qualities of butter are influenced by the character of the food, and that cotton seed and cotton-seed meal tend to the production of a relatively hard butter.

EFFECT OF RIPENING CREAM.—For the relative completeness with which the fat is recovered from sweet and from sour cream see *Churning;* for the quality of sweet and sour-cream butter see *Butter from sweet and sour cream* and *Milk fermentations.*

OTHER POINTS IN BUTTER-MAKING.—The following subjects are treated in station publications: Relation between per cent of cream and yield of butter (*Kans R. 1888, p. 69*); quality of butter not affected by heating milk before setting (*N. Y. Cornell B. 5*); effect of stage at which churn is stopped on quality of butter (*Vt. R. 1890, p. 110; W. Va. R. 1890, p. 29*); washing and salting butter (*Minn B. 7*); comparison between the amount of butter indicated by test and that yielded by the churn (*Kans. R. 1888, p. 149; Ill. B. 9, B. 18; Minn. B. 19; W. Va. R. 1890, p. 29*).

Buttermilk.—See *Butter-making.* For composition and fertilizing ingredients see *Dairy products.* For value for feeding pigs see *Pigs, feeding.*

Butternut trees (*Juglans cinerea*).—The butternut, also known as white walnut, has been planted as a nut tree at the California (*R. 1888–'89, p. 196*), New Mexico (*B. 4*), and Rhode Island Stations (*B. 7*); and as a forest tree at the Minnesota (*R. 1890, p. 38*) and South Dakota Stations (*B. 4, B. 12, B. 15, B. 20, B. 23; R. 1890, p. 16*). The tree appears to endure the Dakota climate, and to make a satisfactory, though not rapid growth. It is recommended for planting in that State. It failed to grow at the New Mexico Station.

Cabbage (*Brassica oleracea*).—The station work on this plant has consisted chiefly of tests of varieties, but culture and manuring have also been considered.

VARIETIES.—Tests of varieties are reported as follows: *Colo. B. 2, R. 1888, p. 126, R. 1890, p. 49; Fla. B. 14; Ga. B. 11; Kans. B. 19; Ky. B. 32, B. 38; La. B. 3, 2d ser.; Md. R. 1889, p. 60; Mich. B. 57, B. 70, B. 79; Minn. B. 5, B. 10, R. 1888, p. 259; Nev. R. 1891, p. 12; N. Y. State R. 1882, p. 130, R. 1883, p. 186, R. 1884, p. 208, R. 1885, p. 125, R. 1886, p. 179, R. 1887, p. 326, R. 1888, p. 118, R. 1889, p. 331, R. 1890, p. 291; Ohio B. vol. II, 7; Ore. B. 4, B. 15; Pa. B. 10, B. 14, R. 1888, p. 142, R. 1890, p. 160; Tex. B. 16; Utah B. 3, R. 1891, p. 52; Va. B. 11.*

In *Minn. R. 1888, p. 267,* the original plant from which the cabbage has been developed is noted, as also the source of the cauliflower, brussels sprouts, kohl-rabi, kale, and the cow cabbage of the Jersey Islands.

A scheme for the classification of cabbages, following that of De Candolle, is advanced by the New York State Station (*R. 1886, p. 193*) and applied to 85 varieties. The primary division is based on the surface of the leaves as smooth or "blistered," corresponding to a common distinction of cabbages and savoys. The secondary division rests on the form of the head according to 5 types. In view of variations in plants from seed of the same name the necessity was felt of adhering in descriptions to an ideal type based on the majority of specimens. But it was also deemed necessary to recognize subvarieties or strains.

The ash constituents of cabbage, as compared with greasewood, are given in *Cal. B. 94.*

The rooting habit of the cabbage was observed at the New York State Station (*R. 1884, p. 313*). The taproot extended to a depth of 20 inches, and the horizontal roots to a distance of about 18 inches on all sides; the fibrous roots lay chiefly in the upper layers of the soil. A test of the question whether transplanted plants headed better than others gave a negative answer (*N. Y. State R. 1886, p. 189*).

The influence of deeper and shallower setting on the heading of cabbages was investigated at the N. Y. Cornell Station (*B. 15, B. 25, B. 37*). The results were conflicting, but indicated that the depth at which strong plants are set is immaterial.

Fertilizing experiments on cabbages are reported from the Massachusetts Hatch Station (*R. 1888, p. 43*) and the New York State Station (*R. 1884, p. 211*). In *Fla. B. 14* methods successfully used in growing cabbage are described, with recommendations.

The opinion that spring and summer cabbages can not be raised in that State was refuted by an experiment in which insect enemies were met with Paris green. In *N. C. B. 74* a discouraging view is taken of the culture of late cabbages in that State.

Methods of culture for early and late cabbages are detailed in *Minn. R. 1888, p. 268*. The Tennessee Station (*B. vol. V, 1*) gives a full account of methods successfully pursued in growing early cabbages.

SEEDS.—Germination tests of cabbage seed are recorded in *Ala. College B. 2; Ark. R. 1889, p. 94; Me. R. 1888, p. 139, R. 1889, p. 150; Mich. B. 57; N. Y. R. 1883, pp. 68, 187, R. 1887, p. 30; Ohio R. 1884, p. 198, R. 1885, pp. 157, 173, R. 1886, p. 254, R. 1887, p. 284; Ore. B. 2, B. 15; Pa. B. 4, B. 8, R. 1889, p. 164; S. C. R. 1888, p. 64; Vt. R. 1889, p. 101.*

At the New York State Station (*B. 30, n. ser., R. 1890, p. 288*) comparative tests were made of cabbage and cauliflower seed imported from Europe and grown on Long Island and at Puget Sound. No advantage was shown for the foreign seed. The Washington seed averaged heavier and had the advantage in a quicker and more vigorous vegetation, resistance to insects, etc., but not otherwise in the final result. A comparison of Puget Sound and Eastern seed at the Ohio Station (*B. vol. II, 7*) gave the same conclusion. A trial of large *vs.* small seed at the New York State Station (*R. 1885, p. 128*) was inconclusive. Another trial indicated that seed from the lower branches of the main stalk is even better than that from terminal pods. Trials at the same station of slightly green as compared with ripe seed (*N. Y. State R. 1884, p. 211, R. 1885, p. 130, R. 1886, p. 190*) indicated at first an advantage for the green seed, but at the last trial the advantage was strongly the other way. An experiment was also made in growing plants from leaf cuttings (*N. Y. State R. 1886, p. 190*). Thrifty plants were obtained in this way more quickly than from seed, but not nearly all grew, and those which grew were less hardy and less variable than seedlings.

Cabbage bug, harlequin (*Murgantia histrionica*).—This is a small, gaudily colored bug, which feeds on cabbages, turnips, mustard, and allied plants. The adult insect is about one half inch long, bluish black in color, with yellow or orange spots and stripes. On the under side of its body are seven transverse lines with orange-colored spots. It lays its eggs in two rows of six or seven each, usually attaching them to the under side of the leaf. The eggs are marked with two black lines. They hatch in a few days into a young insect, resembling the adult, except that it is without wings. There are from two to six broods each season. This insect is so far mostly confined to the southern part of our country. It feeds by sucking the sap from the leaf. On this account poisons do not affect it. Destruction of eggs, hand picking, and catching under little piles of rubbish early in the morning are about the only means known for its repression. (*Del. B. 12; Ga. B. 3; N. C. B. 78; S. C. R. 1888, p. 25.*)

Cabbage butterfly, imported (*Pieris rapæ*).—The mature insect measures about 2 inches across its expanded wings. The wings are white, becoming darker near the body. The tips of the fore wings are black. The male has one and the female two spots on the upper side of the wings, and both have two spots on the under side of the fore wings. On the upper side of the hind wings is an irregular dark spot about in line with the spots on the fore wings. Underneath they are pale lemon color, without spots. The eggs are laid singly, usually on the under side of the leaf. They hatch in about a week and the small worm begins to eat holes through the leaf. When full grown the worms are about an inch in length, green in color, with pale yellow stripes along the back and a row of yellow spots along the sides. When fully developed they wander off under a board, fence, or elsewhere, and there are transformed into butterflies. There are two or three broods in a season, but as the eggs are laid singly they hatch irregularly, so that the broods seem continuous.

Among the best means for destroying this pest are pyrethrum either in decoction or mixed with flour, kerosene emulsion, hot water (140° to 160° F.) sprayed over the heads, lye wash, salt water, and Paris green or London purple (1 ounce to 6 pounds of

flour) sprinkled over the plants. The last two must not be used after the plants begin to head. Fresh air-slaked lime is also recommended. (*Conn. State R. 1890, p. 97; Del. B. 4; Fla. B. 9; Ga. B. 2; Ky. B. 40, R. 1889, p. 9; Iowa B. 5, B. 12; Mass. Hatch B. 12; N. J. R. 1889, p. 302, R. 1890, p. 511; N. C. B. 78; Ohio B. vol. III, 4, vol. IV, 2; S. C. R. 1888, p. 34.*)

Cabbage butterfly, Southern (*Pieris protodice*).—This differs from the imported cabbage butterfly principally in its coloring. The male has three black spots and a narrow black tip on the fore wing; the female has quite a number of irregular spots of black on its wings. The treatment for this insect is the same as that for the imported cabbage butterfly. (*Colo. B. 6; Iowa B. 5; Ky. R. 1889, p. 9; N. C. B. 78; Ohio. B vol. IV, 2; S. C. R. 1888, p. 34, R. 1889, p. 97; S. Dak. B. 13, B. 22.*)

Cabbage club root (*Plasmodiophora brassicæ*).—A fungous disease most abundant on cabbage, but liable to attack any member of the same family, as turnips, radishes, and mustard. This fungus is of a very low order and multiplies with great rapidity in the cells of the host. In some cases it attacks the young plants in the hotbed, causing their roots to become rotten and swollen. In such cases all plants should be destroyed, for the disease is probably present in all and will sooner or later prevent their development. It usually attacks the older roots, causing their decay, and as younger ones are put out above, these are attacked and assume swollen and distorted shapes, from which the name is derived. This continuing, the plants are so weakened that they do not head and the crop is worthless. This pest works underground and is out of the immediate reach of fungicides. Selection of healthy plants, and care that the soil be not infected are the principal means for its repression. If cabbages, turnips, radishes, or mustard are not grown in infected ground for several years the fungus will gradually die out. (*Mass. R. 1891, p. 230; N. J. R. 1890, p. 348; S. C. R. 1888, p. 15.*)

Cabbage maggot (*Anthomyia brassicæ*).—This is the larva of a small fly, and infests young cabbage, turnip, and cauliflower plants. The maggot is very small and easily escapes notice in the crown or roots of the plant. When once infested, the ground should not be used for such crops for a season or two. The maggots may be killed in the hotbed with carbon bisulphide inserted into the soil. Upon transplanting puddle the roots in sulphur and sprinkle afterwards with the same. Kainit used as a fertilizer is said to kill the maggots in the ground. (*N. J. B. 75; N. Y. State R. 1888, p. 147.*)

Cabbage mildew (*Peronospora parasitica*).—A fungous disease which has caused considerable damage in some localities. It spreads a white, webby mass over the surface of the leaves, causing them to wilt and die. It is also found occasionally upon the seed pods of the radish. (*N. J. R. 1890, p. 349.*)

Cabbage mold, black (*Macrosporium brassicæ*).—When abundant this fungous disease does great damage to the cabbage crop, causing the leaves to turn black and drop off. Both this and the mildew would probably be prevented by early spraying with the Bordeaux or other mixtures, although no report is given of their trial. (*N. J. R. 1890, p. 349.*)

Cabbage plusia (*Plusia brassicæ*).—The adult insect is a night or twilight-flying moth, of a dark-gray color, having a silvery spot near the middle of each fore wing. The eggs are laid singly or in clusters upon the cabbage leaves. The larva bears some resemblance to that of the cabbage butterfly, but may be distinguished by its small head, with the body gradually increasing in size towards the hind end, and its habit of looping, after the manner of the span worm or measuring worm when in motion. The larva is about an inch long, pale green in color, with several lighter longitudinal stripes. It infests cabbage, celery, turnips, tomatoes, clover, cauliflower, lettuce, and several other plants.

It may be destroyed with kerosene emulsion or pyrethrum (1 part to 3 parts flour). (*Ohio B. vol. IV, 2, R. 1888, p. 160; S. Dak. B. 13, B. 22.*)

California Station, Berkeley.—Organized in 1876, in connection with the College of Agriculture of the University of California; reorganized in 1888 under the act of Congress of March 2, 1887. Outlying stations have been established as follows: Southern Coast Range at Creston, San Joaquin Valley at Tulare, Sierra Foothill at Jackson, South California at Chino, West Side Santa Clara Valley at Menlo Park, Fresno at Fresno, and East Side Santa Clara Valley at Mission San José. The staff at Berkeley consists of the president of the college, director, geologist, and chemist; superintendent of agricultural grounds; botanist; agricultural geologist and chemist; assistant in agricultural laboratory; assistant in charge of viticulture and olive culture; assistant chemist in viticultural laboratory; inspector of stations; foreman of grounds; foreman of cellar; and clerk to director. There are also seven patrons and four foremen at the outlying stations. The principal lines of work are soils, composition and cultivation of field crops, grapes, and orchard fruits, diseases of plants, seeds, composition of feeding stuffs, entomology, technology (particularly wine and olive oil), drainage, and irrigation. Up to January 1, 1893, the station had published 105 bulletins, besides annual or biennial reports. Revenue in 1892, $26,160.

Calves.—For experiments in raising and in fattening see *Cattle, feeding for beef and for growth.* For dehorning see *Dehorning cattle.* A deformity in a calf attributed to injury to mother is described in *Minn. B. 19.* Conditions affecting the strength of the stomach of the calf for rennet are discussed in *Mass. Hatch B. 11.*

Camomile.—The German camomile (*Matricaria chamomilla*) was found to do well in the climate of Berkeley, California, seeding freely each year (*Cal. R., 1885–'86, p. 126*). The Roman camomile (*Anthemis nobilis*) is stated to be of easy cultivation and perennial. The field camomile (*A. arvensis*) is noted as a weed (*N. Y. Cornell B. 37*).

Camphor trees (*Cinnamomum camphora* [*Camphora officinarum*]).—This tree has been tested in California, and seems well adapted to that State (*R. 1882, p. 106, R. 1885–'86, p. 118, R. 1888–'89 pp. 87, 110, 138*). A tree is instanced 45 feet high, branched low, and fully 3 feet through at the base, at an age of about 20 years. "There is no doubt that the tree will be found adapted to a large portion of the State and will grow without irrigation wherever a pear tree will succeed without it." Extracts from correspondence show that the camphor tree has given satisfaction in many localities in the State. The camphor tree is "an excedingly handsome evergreen, belonging to the laurel family," and is the source of the genuine camphor of commerce. Aside from the value of the drug, the wood, which generally does not enter into its manufacture, has a high value for a number of purposes, and perhaps would alone compensate for the cost of rearing the plantation, leaving the root, young branches, and foliage (the camphor-producing material) at a nominal cost."

Canada thistle.—See *Weeds.*

Cañaigre (*Rumex hymenosepalus*).—This plant, considered as a source of tannin, has recently been under investigation at the California and Arizona Stations (*Ariz. B. 5; Cal. B. 98, R. 1890, p. 123*). The plant is related to the dock and rhubarb, and grows wild in Texas, Arizona, New Mexico, Southern California, and parts of Mexico. The root "has long been used for tanning purposes by the Indians, and also of late years by the tanneries of those districts." The roots bear some resemblance to sweet potatoes, growing in an upright cluster from 3 to 12 inches beneath the surface, the number varying from two to a dozen, the single roots varying from 2 ounces to 1 pound or more in weight. Tannin assays of several samples grown in California were made at the station of that State, and the internal structure of the root, the location of the tannin, and related points were studied. Of 8 samples examined, 6 of which were grown on the station grounds, the tannin percentage proved to be fully as high as that of the native plant in Texas. The average tannin content for the 8 samples was 32 per cent; analyses of 2 Texas samples cited show 26 and 38 per cent. As stated in *Ariz. B. 5,* one-year old roots when dried contain from 25 to 30 per cent of tannic acid—twice as much as oak or hemlock bark. At the California

Station it seemed to be proved that the tannin is contained in the solution in the sap of the root.

At the Arizona Station a study is in progress relating to the economic culture of the plant. It was considered doubtful whether growing in its natural condition it can be placed on the market in large enough quantity and at low enough cost to make it of commercial importance, owing to its being scattered over large areas and requiring to be dug by hand. Inquiry was therefore instituted as to its response to cultivation, its need of irrigation, the effect of irrigation on the quantity and quality of tannin, and the best-adapted soils. "The cañaigre root has been tested in the manufacture of leather in this country and abroad sufficiently to show that the tannin extracted from it, either alone or with tannin from other sources, will make good leather, but much remains to be done to open up a market."

In *Cal. B. 98* (Dec., 1892) a report is noted "that gatherings of the wild root have been so large during the last two years that it is difficult to obtain it in quantity, and plantations recently made in New Mexico have proved profitable, $5 per ton being paid for the green root, which is worth $60 to $80 per ton dried and delivered in Europe. The yield in cultivated land is said to reach 16 tons to the acre of green root."

Canary grass.—See *Grasses.*

Cankerworms (*Anisopteryx vernata* and *A. pometaria*).—The principal difference between these two species (known as spring and fall cankerworm, respectively) is in the time of laying their eggs, the former laying them in the spring and the latter in the fall. In each species the male is a moth of a grayish color, about an inch across the wings. On the fore wings are irregular bands of color. The female is about $\frac{1}{3}$ to $\frac{1}{2}$ inch long and wingless, and is said to look somewhat like a spider. The eggs are laid upon the twigs and hatch as soon as the leaves appear. At first the worms are very small and are easily overlooked. When full grown they are about an inch long, of color varying from gray to brown, with lighter stripes and dark-brown heads. From their looping mode of motion they are called measuring worms. They eat the leaves of apple, pear, peach, and other fruit trees, as well as of the elm.

Preventive treatment consists in smearing the trunks of the trees with tar or printer's ink mixed with oil to prevent hardening, at intervals from early spring until July. This will prevent the wingless females from climbing up the trees to deposit their eggs. Another method of treatment is to place inverted cones about the trees, in which oil or something similar is put. The worms may be killed by one or two early sprayings with Paris green or London purple (1 pound to 150 gallons of water). (*Me. R. 1888, p. 152, R. 1890, p. 137; N. C. B. 78; N. Y. State B. 35; Ohio B. vol. II, 1, R. 1888, p. 132; Ore. B. 18; R. I. B. 15; Vt. R. 1889, p. 152*).

Cantaloupe.—See *Muskmelon.*

Cape gooseberry.—See *Physalis.*

Caper bush (*Capparis spinosa;* also var. *inermis*).—This was grown at the California Station at Berkeley, but is better adapted to a warmer locality, and a sandy, rocky, and dry soil (*Cal R. 1880, p. 66, R. 1882, p. 107*).

Capons.—See *Poultry.*

Carbohydrates in feeding stuffs.—See *Feeding farm animals.*

Cardoon (*Cynara cardunculus*).—A vegetable closely resembling and related to the true artichoke. For brief mention of varieties and seed tests, see *N. Y. State R. 1883, pp. 68, 263, R. 1884, p. 287.*

Carica.—See *Melon tree.*

Carnations (*Dianthus caryophyllus*).—In *Ind. B. 20* experiments are recorded in cross-fertilizing these flowers. The results indicated that crossing of different stocks is essential to the production of varieties distinct in color, and that "a clear, sunny day, of relatively high temperature and dry atmosphere, gives the best condition for this work."

At the Massachusetts Hatch Station (*B. 10, B. 15*) several special fertilizers were tested upon carnations under glass. In a trial of single fertilizers results favored dissolved boneblack and sulphate of potash (applied in liquid form) as compared with muriate of potash, nitrate of soda, sulphate of ammonia, and ordinary liquid manure. Out of thirteen combinations of fertilizers, sulphate of potash with sulphate of ammonia gave the best results. In a second test of six single fertilizers nitrate of potash gave the best results, sulphate of potash the next best, and dissolved boneblack the poorest, perhaps owing to its insoluble condition.

Carnations, diseases.—*Septoria dianthi* and *Vermicularia subeffigurata* are the leading fungous diseases of carnations. The first is observed on the leaves as pink discolorations, which soon turn brown. The affected portion of the leaf becomes dotted over with dark pimples and then dies, while the decay spreads until the whole leaf is involved. In the second the base of the leaf is attacked or the stem between the bases and soon black specks appear, bearing an abundance of spores. Often the two diseases act together. In bad cases the plants lose their green color and fail to bloom. Some varieties are more liable to attack than others. The carbonate of copper and ammonia compounds have been used with good results, but all depends upon taking the work in hand early in the season.

A kind of anthracnose is also troublesome. When present on carnations the affected parts present a pale appearance, except that the surface is dotted with minute nearly black specks that are seen to be bristly, with small stiff hairs. This does most damage to "slips." Upon examination, the cuttings will be found infested with the minute black rosettes. Recent experiments with ½ ounce sulphide of potassium to 1 gallon of water used as a spray have given good results for both this and the above-mentioned diseases of carnations. (*N. J. R. 1890, p. 363, R. 1891, p. 300.*)

CARNATIONS, RUST (*Uromyces caryophyllinus*). Although long known in Europe, the disease has been but recently discovered in this country and is doing considerable damage to plants, especially in greenhouses. It may be distinguished by medium-sized plump gray blisters upon the leaves and stems. Like all the other rusts, when these blisters appear the fungus has completed its growth, and is coming to the surface to scatter its spores. The spores are light brown and exceedingly numerous. A plant once infected should be removed and burned. Healthy ones may be kept so by spraying with some of the solutions of copper salts. (*Ind. R. 1891, p. 28; N. J. R. 1891, p. 302.*)

Carob (*Ceratonia siliqua*).—This tree has excited considerable interest at the California Station, and data respecting its value and the success of plantations in California may be found in *Cal. R. 1880, p. 66, R. 1882, p. 107, R. 1884, p. 100, R. 1885–'86, p. 108, R. 1890, p. 230.* In *Cal. R. 1884, p. 100,* a description is given of the tree and its uses, of the conditions favorable to it, and of the method of its propagation and culture. It is found in nearly all countries around the Mediterranean, and its fruit, known as St. John's bread, a pod 6 to 10 inches long and three-fourths to 1¼ inches broad, is an important product and article of export. It is largely imported into England, where it is used as an admixture in cattle feed. Detailed directions are given for its propagation by seed.

In 1890 from experience in California the conclusions reached were: "No tree distributed by the station is more likely to make a popular shade and ornamental tree for dry, rocky situations than is the true carob of southern Europe and Asia Minor. Aside from the fruit, whose well-attested economic value ought to induce more planting, the tree is of striking and attractive appearance. In rich valley soils it does not bear early nor yield so abundantly as in its own home, the warm, rocky hill country" (*Cal. R. 1890, p. 230*). It is held proved that the carob will grow with less water than any other fruit, the olive not excepted. In some localities it yielded to frost. Superior varieties are secured by grafting and budding, and by these means the tree is brought into bearing earlier.

Carrot (*Daucus carota*).—VARIETIES.—Tests of varieties are recorded as follows: *Colo. B. 2, R. 1888, p. 145, R. 1889, pp. 41, 99, R. 1890, p. 191; Md. R. 1889, p. 60; Mich. B. 46, B. 60; Minn. R. 1888, p. 245; Nebr. B. 12; N. Y. State R. 1882, p. 122, R. 1883, p. 179, R. 1884, p. 193, R. 1885, p. 121, R. 1886, p. 235, R. 1887, p. 318, R. 1889, pp. 275, 326; Ohio R. 1884, p. 132, R. 1885, p. 121, R. 1887, p. 224; Ore. B. 4; Pa. B. 14, R. 1888, p. 142; Vt. R. 1889, p. 129.*

In *N. Y. State R. 1887, p. 133*, a classification is made of 28 varieties according to the form of the root end, length of the root relative to its thickness, and its color. The varieties are fully described, English and foreign synonyms given, and the names indexed.

COMPOSITION.—For food constituents see *Appendix, Table I.* Compiled analyses (food and fertilizing constituents) of carrots, root and dried tops, are given in *Mass. State R. 1890, p. 293, R. 1891, pp. 317, 318.* For sugar content of the root see *Minn. R. 1888, p. 103.*

SEED.—Germination tests are reported in *Me. R. 1888, p. 141, R. 1889, p. 150; N. Y. State R. 1883, pp. 68, 179; Ohio R. 1884, p. 200, R. 1885, p. 175; Ore. B. 2; Vt. R. 1889, p. 102.*

FEEDING EXPERIMENTS.—See also *Silage.* Carrots were used in feeding experiments with milch cows at the Massachusetts State Station each season from 1887 to 1889 (*R. 1887, p. 11, R. 1888, p. 11, R. 1889, p. 37*). The special object was to compare the feeding value of carrots (and sugar beets) with that of corn silage. In *R. 1888, p. 17,* it is stated that "the nutritive feeding value of carrots, taking into consideration pound for pound the dry matter they contain, exceeds that of corn silage as an ingredient of the daily diet, in place of a part (one half) of the hay fed."

Casein.—See *Milk* and *Cheese-making.*

Cassava.—Cuttings of the sweet cassava (*Manihot aipi*) were offered for distribution by the California Station (*B. 95*). Attention has been attracted by its approval in the Southern States, but no wide success in California is predicted on account of the dry conditions of that State. Some account is given of its adaptations as represented in Florida, and of the method of culture. It has been commended as a kitchen vegetable, the root being used like potatoes. As a food for cows, both leaves and roots thus used, the latter being regarded as far superior to sweet potatoes for milch cows.

Catalpa.—The *Catalpa bignonioides* of the South is noted (*Ala. College B. 3, 1889*) as a handsome tree, of rapid growth, reaching a height of 60 feet or more. The wood is gray-white, fine-grained, and takes a high polish.

The *C. speciosa* (showy or hardy catalpa) as noted in *S. Dak. R. 1888, p. 24,* has been more extensively experimented with in the West than almost any other tree. In South Dakota it appears to be out of its latitude. Likewise at the Minnesota Station (*B. 24*) it has been found very unreliable, and is not regarded as valuable for timber in any part of the State, though it may be made to flower in some sheltered locations. In *Cal. R. 1885–'86 p. 119* it is stated that it will be at a disadvantage as compared with the eucalyptus in the coast region, on account of the winds tearing its soft leaves, but will find a suitable location inland. A note in *Cal. R. 1890, p. 235,* indicates that the catalpas sent out to all parts of the State had done very well. Among the species of catalpa grown in the collections of several States is the Japanese *C. kæmpferi.*

Cattle, feeding for beef and for growth.—Under this head will be included experiments in feeding cows, calves, steers, and oxen for beef and for growth.

COWS FED FOR BEEF.—The Maryland Station (*B. 8*) reports a comparison of the cost of fattening cows nine to ten years old and five to six years old, feeding corn meal, wheat middlings, linseed meal and Hungarian hay or corn stover. In eight weeks the two older cows gained 105 pounds, at a cost for food of $20.65 or

nearly 20 cents per pound of gain, and the two younger cows gained 209 pounds, at a cost of $21.95, or about 10½ cents per pound.

A cow fed at the North Carolina Station (*B. 81*) for 57 days on cotton hulls and meal, with a small addition of other coarse fodder, gained 111 pounds live weight, giving a profit, exclusive of manure, of $6.37.

Wide *vs.* narrow nutritive ratio, *N. Y. State R. 1887, p. 23.* Fattening old cows on cotton-seed products, *Tex. B. 6.*

Calves fed for beef and for growth.—The New York State Station (*R. 1885, p. 25*) fed two calves five weeks old for 100 days in periods as shown below:

Average gains in live weight of calves, and cost of the same.

Periods.	Food.	Average daily gain in weight.	Cost of food per lb. of gain.
		Pounds.	*Cents.*
July 14–31	Whole milk	1.39	12
Aug. 1–Sept. 6	Whole milk and grain	1.52	9½
Sept. 7–Oct. 6	Grain and green clover	1.30	3½
Oct. 7–21	Grain and grass	1.57	4⅝
Averages		1.48	7¼

The grain consisted of a mixture of linseed meal, ground oats, and bran, valued at current prices. The milk was valued at 1 cent per pound and the clover at $4 per ton.

A short comparison of whole milk and separator skim milk at the Mississippi Station (*R. 1888, p. 43*) was favorable to the latter. The calves receiving 10 pounds of skim milk made nearly as large gains as those receiving 8 pounds of whole milk. Whole milk and skim milk from deep setting were also compared at the Iowa Station (*B. 14*), 1½ pounds of flaxseed meal per day being added to the skim-milk ration. The lot on whole milk made the largest gain in 91 days, but the result is regarded as very favorable to the skim-milk ration, for the calves on that ration appeared in the best condition and were fed more cheaply. Estimating whole milk at 87½ cents and skim milk at 15 cents per 100 pounds, flaxseed meal at 3½ cents per pound, etc., the cost of food per pound of gain was 7.6 cents for the whole-milk lot and 5 cents for the skim-milk lot. The above trial included a Shorthorn and a Holstein in each lot. The Holsteins in each case made the larger gain in weight.

Two calves fed together on skim milk, linseed meal, and ground oats at the Wisconsin Station (*R. 1883, p. 37*) averaged 1 pound of growth for 13 pounds of milk, ½ pound of linseed meal, and ⅓ pound of oats. The same station noticed that the skim milk from centrifugal creameries was often thrown away because it soured so rapidly, and made experiments bearing on the value of curdled skim milk (*Wis. R. 1886, p. 21*). Skim milk was curdled by heating with liquid rennet and the whey was poured off. The curd with the whey remaining with it constituted about 60 per cent by weight of the whole. In two trials calves were fed on this curd a month and then for a month following on sweet skim milk. The gains were nearly as large on the curd as on skim milk, and larger amounts of grain were eaten with the skim milk.

A trial of raising scrub stock at the New York State Station (*R. 1890, p. 359*) brought out the undesirability of feeding late-maturing animals or those which do not consume food enough to make a profitable growth.

In a trial of fattening a large number of calves on various foods the Mississippi Station (*B. 8*) observed that the grade Jerseys increased in weight more rapidly than the grade Holsteins. (See also *Cotton seed and cotton-seed meal for beef production.*) (*Mo. College B. 27; N. Y. State R. 1887, p. 23; Pa. B. 17.*)

STEERS FED FOR BEEF AND FOR GROWTH.—The experiments on this subject are discussed below under the following heads: (1) Feeding steers of different breeds, (2) feeding for fat and for lean, (3) age as a factor in determining the cost of gain, (4) sheltering beef cattle, (5) whole corn, corn meal, and corn-and-cob meal, (6) cotton hulls, (7) feeding grain to steers at pasture, (8) hay *vs.* straw, and (9) miscellaneous.

In addition to this, experiments in feeding steers are reported elsewhere under the following heads: *Cotton seed and cotton-seed meal for beef production* and *Pasturage.*

(1) *Feeding steers of different breeds.*—The Maine Station (*R. 1890, p. 71*) compared the relative gains during 233 days of Holstein, Shorthorn, and Hereford steers, all between five and eight months old. The Holsteins made an average daily gain of 1.78 pounds, the Shorthorns 1.63 pounds, and the Herefords 1.51 pounds per head. In two experiments in growing Shorthorn, Galloway, Holstein, Jersey, Hereford, and Devon steers from calves to maturity the Michigan Station (*B. 44, B. 69*) observed no breed differences affecting the cost per pound of gain. The age and "type" of the animals seemed to be the controlling factors. Those of the "meat type" of stocky form, made more economical gains than those of the "dairy type."

The Ontario (Canada) Station (*B. 70*) compared grades of Galloway, Shorthorn, Aberdeen, Angus, Hereford, Devon, and Holstein breeds with natives, all under two months old at the beginning of the test, for a period of one year. The largest profit was with the Galloway. The grades were valued by an expert at from 4.75 to 5.5 cents per pound live weight while the native was valued at only 3.75 cents.

(*Ill. R. 1886, p. 216; Mich. B. 24, B. 30; Miss. B. 8; N. Y. State R. 1889, p. 186, R. 1890, p 20.*)

(2) *Feeding for fat and for lean, nitrogenous vs. carbonaceous ration.*—The theory has been advanced that the relative production of fat and lean meat can be largely influenced by feeding. Experiments bearing on this question have been mainly with pigs (see *Pigs, feeding for fat and for lean*), but two are reported with cattle. At the Missouri College (*B. 27*) Prof. Sanborn fed calves on a ration containing different proportions of protein (nitrogenous material). The nutritive ratio (ratio of nitrogenous to non-nitrogenous nutrients) of the food of one lot was 1:2.4 (narrow) and of the other lot 1:5.5. Both lots gained practically the same amount in weight, but the character of the growth was quite different. There was nearly one-fourth more fat on the intestinal and vital organs of the lot on the wider ration (1:5.5) than in case of the other lot. "The meat of lot 1 [ratio 1:2.4] was distinctly more fibrous in character and showed a denser fiber without the light streaking of fat." In a trial with two-year-old steers at the Pennsylvania Agricultural College (*R. 1886, p. 227*) an increase in the amount of protein fed "does not seem to have increased the nitrogen in fresh muscle."

The New York State Station (*R. 1889, p. 117*) compared rations with a wide nutritive ratio (carbonaceous) and a narrow ratio (nitrogenous), the difference in proportion of nitrogen or protein being brought about by substituting a part of the corn meal in the carbonaceous ration with cotton-seed meal, linseed meal, or gluten meal. "In general appearance the lot fed the nitrogenous ration was much the better, having a cleaner, brighter coat of hair. The photographs of the meat show little if any difference in the proportion of fat and lean." The meat of the animals fed on the carbonaceous ration (corn meal largely) was thought to be "much the tenderer and sweeter."

The Arkansas Station (*R. 1890, p. 134*) found "no difference in appearance between the lot fed cotton-seed meal and hulls, and the lot fed corn and pea-vine hay, and no detrimental effects from the cotton-seed products fed the animals."

(3) *Age as a factor in determining the cost of gain.*—In the case of steers, as in that of pigs, the cost of producing a pound of gain increases with the age and weight of the animal. This emphasizes the demand for early-maturing animals for profitable fattening. On this point the Massachusetts State Station (*B. 40, R. 1891, p. 110*) found that two-year-old steers consumed nearly twice as much food per pound of

gain in weight as yearlings. Taking the value of the manure into account, the net cost of food per pound of gain was $2\frac{3}{4}$ to 3 cents with the yearlings and $4\frac{1}{2}$ to $4\frac{3}{4}$ cents with the two-year-olds. The same was indicated by trials at the Pennsylvania Agricultural College (*B. 10*), but in a repetition of the trial the following year the cost of gain per pound was practically the same for two-year-olds as for three-year-olds (*R. 1886, p. 179*).

The Michigan Station (*B. 69*) reports age as the "all-controlling circumstance that decides the rate of gain. The ration necessary to sustain the gain increases with age. * * * The superiority of beef breeds is largely in their early maturity." (*Mich. B. 44.*)

At the Wisconsin Station (*R. 1886, p. 44*) a lot of steer calves from four days to four weeks old were fed for two years. At current prices the cost of food per 100 pounds of gain in weight was $4.19 during the first period, 308 days, and $6.13 during the second period, 422 days (see also *Wis. R. 1888, p. 91*).

(4) *Sheltering beef cattle.*—At the Iowa Station (*B. 6*) the cost of making 100 pounds of gain in live weight was $3.89 for barn-fed steers, and $5.10 for steers fed the same food in the yard with only an open shelter. The barn-fed steers ate 1,184 pounds of dry matter and the yard-fed steers 1,361 pounds of dry matter for each 100 pounds gained.

At the Texas Station (*B. 6*) the cost of gain under shelter and out of doors was compared during January, February, and March, the same food being fed to both lots. For every 100 pounds gained, the cost of food eaten was $4.17 with the sheltered steers and $6.83 with those out of doors.

At the Utah Station (*B. 11*) steers kept out of doors ate considerably more food than those fed in the barn. Blanketing steers in the barn was found to be of no advantage.

(5) *Whole corn, corn meal, and corn-and-cob meal.*—As to the value of grinding corn for steers, in a trial at the Missouri Agricultural College (*B. 2*) steers made much better gains on corn meal than on whole corn. At the Virginia Station (*B. 10*) the results agreed with this, whether silage or hay was fed as coarse fodder. Allowing the same price for whole corn and corn meal ($20), the average cost of food per pound of gain ranged from 7.35 to 9.35 cents for the corn meal lots and from 9.3 to 17.5 cents for the whole corn lots. Allowing one-seventh for toll for grinding the corn, "the balance is still much in favor of the meal-fed lot."

Two experiments on the subject made at the Wisconsin Station (*R. 1888, p. 91*) were contradictory. The results of one experiment favored corn meal and those of the other whole corn, though the advantage was slight in either case. When hogs ran in the pasture with the steers the combined gains of the hogs and steers were favorable to whole corn in both trials.

A comparison of whole shelled corn with corn-and-cob meal was made at the Iowa Station (*B. 6*), feeding each with corn fodder to two steers. Valuing shelled corn at 38 cents, corn-and-cob meal at 34 cents per 100 pounds and corn fodder at $2. 50 per ton, "shelled corn produced gain more cheaply than corn-and-cob meal," and at a smaller consumption of dry matter per pound of gain. (See also *Tex. B. 6.*)

Corn-and-cob meal was compared with coarse ground corn meal at the Kansas Station (*R. 1885–'86, p. 101*) with a result quite favorable to the corn-and-cob meal. About the same amount of each meal was eaten, but the lot on corn-and-cob meal gained the most. The gain in weight from a bushel of corn ground with its cobs was 9.56 pounds and from a bushel of ground shelled corn 7.04 pounds. The author believes the result shows corn-and-cob meal to be worth more, pound for pound, than corn meal, for steers.

At the Texas Station (*B. 2, R. 1888, p. 19*) steers gained slightly less on coarse ground corn than on the same amount of corn ground with the cobs and husks, although it was considered doubtful whether the extra gain would pay for grinding the cobs and husks.

At the Maine Station (*R. 1887, p. 93*) "the substitution of cotton-seed meal or linseed meal for a portion of the corn meal of a moderate ration diminished the cost of production."

At the New York State Station (*R. 1889, p. 117*) the substitution of cotton-seed meal, linseed meal, or gluten meal for a part of the corn meal of a ration "was not followed by any advantage so far as the increase in live weight indicated," although the general appearance of the lot so fed was superior to that of the lot fed corn meal. See also *Cotton seed and cotton-seed meal for beef production.*

(6) *Cotton-seed hulls* are fed to steers quite commonly in the South in connection with cotton-seed meal. The ration ordinarily fed to a steer of 700 to 1,000 pounds is from 15 to 20 pounds of hulls and from 4 to 8 pounds of cotton-seed meal per day. An experiment made at the Texas Station (*B. 6, R. 1889, p. 111*) indicated that hulls had a higher nutritive value than corn silage. In another experiment at the same station (*B. 10*) the addition of silage to a ration of cotton-seed meal and hulls increased the total gain, but did not change the cost of gain per pound. As compared with hulls, steers fed on silage gained 2.54 pounds per day and on hulls 2.29 pounds, cotton-seed meal being added in each case. The cost of food per 100 pounds of gain with hulls at $3 and silage at $2 per ton, was $3.83 on silage and $3.73 on hulls, indicating that silage causes a more rapid but a more expensive gain than hulls. The addition of hay to a ration of cotton-seed meal and hulls increased the total gain and also increased the cost per pound of gain. A half pint of molasses per day caused an increased consumption of cotton-seed meal and hulls, and consequently a more rapid gain.

At the North Carolina Station (*B. 81*) 4 steers fattened on cotton hulls and cotton-seed meal made an average gain of 148 pounds each in 84 days, at a cost of $7.25. The net profits for the feed ranged from $6.89 to $10.57 with different animals. A comparison at the same station of the effect of adding corn fodder and silage to the ration of cotton hulls and cotton-seed meal showed little difference in the gains, although the best financial result was from adding the fodder or silage.

A bull stag of 880 pounds fed at the same station in summer on cotton hulls and meal gained 141 pounds, at a cost of $5.24, leaving a fair profit. From its experiments the station concludes that steers do best when about 1 pound of cotton seed meal is fed to each 4 pounds of cotton hulls. (*Ark. B. 9, R. 1889, p. 78, R. 1890, p. 134; N. C. B. 80c.; Tex. B. 15, R. 1889, p. 107.*)

(7) *Feeding grain to steers at pasture.*—Two trials made at the Missouri College (*B. 8*) of feeding a daily ration of 4 pounds of meal or ship stuff to steers on good pasture resulted in a financial loss. The results of two years' trials at the Illinois College (*B. Sept., 1885, R. 1886, p. 211*) indicated "that a grain ration fed to young steers on good pasture is not usually profitable. * * * It is doubtful if at present in most parts of Illinois cattle can be maintained or an increase of weight be secured at so low a cost in any other way as by allowing them to get all their food during the best of the grazing season from good pastures, fully, but not overstocked." An experiment on this subject at the Maine Station (*R. 1888, p. 22*) was a failure.

(8) *Hay vs. straw.*—An experiment at the Maine Station (*R. 1886, p. 73*) indicated that steers made a cheaper gain on oat straw (at $6 per ton), with a little cotton-seed meal and corn meal, than on mixed hay (at $14), with corn meal, although the hay-fed lot gained slightly more.

In another trial at the same station (*R. 1887, p. 89*) the gain in weight was nearly a pound more per day and per steer on 10 pounds of hay than on 12 pounds of oat straw, feeding the same grain ration in both cases. The total cost of food per pound of gain was also more on the straw ration.

(9) *Miscellaneous experiments with steers.*—A short experiment at the Minnesota Station (*R. 1888, p. 123*) resulted favorably to bran as compared with corn. "Part bran instead of all corn as a grain feed to supplement corn silage proved the better for fattening steers."

At the Missouri College (*B. 2*) "crushed corn fodder gave as good results, when grain was fed in moderate quantities, as hay." In a number of trials at the same place (*B. 11*) less clover hay and straw than of good timothy hay was required for a pound of gain. In a comparison of timothy hay cut when in bloom and after the seeds were quite fully formed, the amount of digestible matter in hay consumed per pound of gain in weight was 3.18 pounds of the late-cut and 3.30 of the early-cut timothy, indicating "practically no difference in the feeding value of the two lots of hay."

The Tennessee Station (*B. vol. IV, 1*) found that steers did not eat second-crop clover hay as readily as first-crop hay, and gained only one-sixth as much in weight as on first-crop; in other words, they could not be induced to eat much more than a maintenance ration of it. In a trial at the Indiana Station (*B. 37*) steers made a much more rapid growth on cut than on uncut clover hay.

At the Minnesota Station (*B. 4, R. 1888, p. 126*) steers were more thrifty on cold than on heated water.

(*Ark. B. 9; Mass. State B. 40, R. 1891, p. 107; Miss. R. 1889, p. 36; N. Y. State R. 1889, p. 186; Pa. R. 1888, p. 77; Va. B. 3; Wis. R. 1886, p. 61.*)

WORK OXEN FED FOR BEEF.—A trial at the Alabama Canebrake Station (*B. 8*) of fattening work oxen on hay, corn meal, cotton seed and cotton hulls resulted in a financial loss.

At the Maryland Station (*B. 8*) two work oxen made profitable gains on corn meal, cotton-seed meal, hay, rye straw, and molasses, gaining 600 pounds in 116 days. The calculated profits from the transaction, reckoning the food at current prices and allowing for the manure produced, was $33.42, or a net profit of 15 per cent on the investment in four months.

Four oxen were fed at the North Carolina Station (*B. 81*) to compare cotton hulls with corn silage, feeding cotton-seed meal with each. "In this experiment silage at $1 per ton would about equal cotton hulls at $2.50 per ton, without cost of transportation."

Cattle foods.—See *Foods*.

Cauliflower (*Brassica oleracea* var.).—Variety tests are reported as follows: *Ark. R. 1889, p. 103; Colo. R. 1890, p. 190; Mass. State R. 1889, p. 172; Mich. B. 57; Minn. R. 1888, p. 259; N. Y. State R. 1882, p. 133, R. 1883, p. 187, R. 1884, p. 212, R. 1885, p. 130, R. 1888, p. 119, R. 1889, p. 331, R. 1890, p. 288; Ohio B. vol. II, 7; Ore. B. 4, B. 7, B. 15; Pa. B. 10, B. 14, R. 1888, p. 144; R. I. R. 1890, p. 159; Utah B. 3, R. 1891, p. 57; Va. B. 11.* In *Fla. B. 1* a note is made on the feasibility of growing cauliflower in that State.

Germination tests of cauliflower seed are recorded in *Mich. B. 57; N. Y. State B. 30, n. ser., R. 1882, p. 133, R. 1883, pp. 68, 188; Ohio R. 1884, p. 197, R. 1885, pp. 166, 175; Ore. B. 2; Pa. B. 4; Vt. R. 1889, p. 103.*

Comparisons have been made between European and domestic and Puget Sound and Eastern cauliflower seed, together with cabbage seed, with inconclusive results (*Ohio B. vol. II, 7; N. Y. State B. 30, n. ser.*). See *Cabbage*. Cauliflower seed from Washington State and from Europe compared at the Minnesota Station (*B. 12*) were of nearly equal value, which would give the preference to the cheaper American seed. A trial of large *vs.* small seed at the New York State Station (*R. 1885, p 131*) showed for the latter heads an inch thicker and about sixteen days later in maturing. At the New York State Station (*B 30, n. ser.*) it was found that only about half of the early cauliflowers developed heads, while 96.12 per cent of the late ones did so. The early varieties were more remunerative.

Cedar trees.—The red cedar or juniper (*Juniperus virginiana*) is noted (*Kans. B. 10*) as the favorite conifer for planting in Kansas, not so much from its beauty as from its hardiness in all parts of the State where conifers will survive. It is native on river bluffs south and east from the middle of the State. It is found growing also in many parts of Minnesota (*B. 24*). "It does well in the driest

and most exposed as well as in the most sheltered localities, and forms an admirable wind-break," especially when grown in alternate rows with white or Scotch pine. Plantations at the South Dakota Station are noted (*B. 12, B. 15, B. 23, R. 1888, p. 26*). In *B. 23* it is stated that this, with Scotch pine and white spruce, can be grown in any part of the State.

The Japan cedar (*Retinospora plumosa*) was found at the Minnesota Station (*B. 24*) too tender to be grown in that State. This species is briefly noted in *Cal. R. 1880, p. 69.*

For white cedar see *Arbor-vitæ.*

Celeriac.—A form of the celery plant in which the root is used for food instead of the blanched stems. A variety test is noted in *N. Y. State R. 1884, p. 219* and in *R. 1887, p. 215* a full description of 5 varieties is given, with an index of synonyms and general notes. "The varieties are few in number and differ chiefly in the amount of foliage and the size and neatness of the roots, the latter being almost entirely enveloped in side roots in less improved varieties, and tolerably free from them in those more improved." When first introduced the root was much larger than now. Germination tests of celeriac seed are recorded in *N. Y. State R. 1883, p. 68; Vt. R. 1889, p. 104.*

Celery (*Apium graveolens*).—This vegetable has been planted at several stations for comparison of varieties and for testing methods of culture. In *N. Y. State R. 1887, p. 217*, an account is given of 25 nominal varieties, only about 10 of which were found to be well distinguished. An index of synonyms is also given. Variety tests are also reported in *Ark. R. 1889, p. 103; Colo. R. 1889, p. 39, R. 1890, p. 212; Ky. B. 32; Mass. State R. 1891, p. 195; Mich. B. 79; Minn. R. 1888, p. 259; N. Y. State R. 1882, p. 136, R. 1883, p. 191, R. 1884, p. 218, R. 1885, p. 177, R. 1886, p. 241, R. 1890, p. 287; Ohio R. 1882, p. 62; Ore. B. 4; Pa. B. 10; Vt. R. 1889, p. 130.* A trial at the Florida Station (*B. 1*) indicated success in the culture of celery in that State. At the New York State Station (*R. 1883, p. 190, R. 1884, p. 218*) comparative tests were made of trench culture with a large amount of manure and level culture with moderate manuring. The first year no advantage was shown for trenching; the second the advantage was considerable, taken as indicating under the conditions which existed that injuries resulting from drought may be in some measure averted by growing in trenches. An article occurs in *N. C. B. 83* representing the possibility of growing celery in that State during the winter and giving full directions for its management. It is not thought that Southern celery can compete with Northern in the Northern market. Notes are made on celery culture in *Ohio R. 1885, p. 125,* and *Colo. R. 1889, p. 38.*

Germination tests of celery seed are on record in *Me. R. 1888, p. 140, R. 1889, p. 150; N. Y. State R. 1883, pp. 68, 191; Ore. B. 2; Vt. R. 1889, p. 103.*

Celery, bacterial disease.—This disease is of recent discovery and seems to be most prevalent on the Golden Plume and similar varieties. The affected leaves are badly blotched with brown and have a watery appearance. The disease spreads rapidly in the presence of moisture and is not confined to the growing crops, but may manifest itself in the market, the heart of the stem melting away into a watery, worthless mass. In the market celery should be kept perfectly dry or completely covered with pure water, either method preventing the spread of the bacteria. Spraying with the solution recommended for celery blight (see below), if begun early and frequently repeated, will save the crop. (*N. J. B. Q, R. 1891, p. 257*).

Celery blight (*Cercospora apii*).—A fungous disease causing spots of an ashy color more or less scattered over the leaves. The filaments of the fungus are irregularly scattered through the tissues of the leaf. Opinions vary somewhat as to the conditions under which it makes most headway. Some claim it disappears with the hot summer days, others that it is worse upon the coming of the autumn rains.

This difference of opinion may be due to the confounding of several of the celery diseases, or to the fact that the growth of the host has been so vigorous, as to over-

come the fungus. In spraying experiments the standard solution of carbonate of copper gave the best results. In one case the treated plants were not free of the blight, but the harvested product of a 25-foot row was about double that of an untreated row by its side and the difference in quality was still greater. Perhaps an earlier application while the plants were small, would have completely prevented the disease.

Another blight (*Septoria petroselini* var. *apii*) has been found recently in considerable quantity, which causes the whole leaf to become brown and dead. A plant at all affected is liable to show all the foliage diseased and dying, with small black dots plentifully sprinkled over its surface. The treatment recommended is the same as in the former case. (*N. J. B. Q, R. 1891, p. 255.*)

Celery leaf spot (*Phyllosticta apii*).—A fungous disease first recognized by a light brown spot, which increases in size and becomes darker in color, causing the whole affected portion to become brown and lifeless, and giving to the leaf a torn and ragged appearance. A single spot may be all that one leaf will show, the rest being bright and green, but the torn appearance will indicate its presence. This disease flourishes best in shade and moisture and is especially severe on the young leaves. Early spraying with the same solution as recommended for celery blight, (see above) is suggested as a preventive treatment. (*N. J. B. Q. R. 1891, p. 253.*)

Celery rusts (*Puccinia bullata* and *P. castagneii*).—These rusts are common in Europe, the first wherever celery is grown, the other only in France. They have not been reported on celery in this country yet, but may be expected at almost any time. They may be recognized by their small and numerous spots followed by the appearance of masses of spores. The application of Bordeaux or ammoniacal carbonate of copper compounds would probably be found beneficial. (*N. J. B. Q, R. 1891, p. 256.*)

Cellulose in feeding stuffs.—See *Feeding farm animals*, and *Appendix, Tables I and II.*

Chapman honey plant.—See *Bee plants.*

Charbon.—See *Anthrax.*

Chard.—"A plant of the beet family in which the foliage instead of the root has been developed through selection." The bleached leaf stalk and midrib are used for the table. An examination of the root system of the "Swiss chard" showed that it was more extensive than that of the garden beet. A branch was traced horizontally a distance of 3½ feet, and the taproot at a depth of 2 feet had the thickness of a wheat straw. (*N. Y. State R. 1884, pp. 191, 311.*)

Cheat.—See *Weeds.*

Cheese, composition.—Analyses of cheese have been reported, among others, in *Colo. R. 1888, p. 151; Mass. State R. 1889, p. 312, R. 1890, p. 311, R. 1891, p. 337; Minn. B. 19; N. Y. State B. 37, R. 1891, p. 233; Vt. R. 1891, pp. 90, 97, 119.*

For a summary of American analyses of cheese, with reference to both food and fertilizing ingredients, see *Dairy products.*

Cheese factories.—Paying for milk at cheese factories on the basis of quality rather than quantity has been advocated for reasons similar to those which commend the practice at creameries (see *Creameries*). The New York State Station (*B. 37*) among others has advocated the fat content of the milk as the basis for payment for the reasons that "(1) the milk fat appears to exercise a greater influence upon the composition and yield of cheese than any other constituent, and therefore forms a just basis for estimating the cheese-producing efficiency of factory milk; (2) it induces dairymen to produce a better quality of milk; and (3) it removes any temptation to adulterate milk." The Vermont Station, on the other hand, proposes (*B. 21*) to take account of both the fat and the casein, contending that "it is not a fact that twice as much cheese can be made from milk containing 6 per cent of fat as from milk containing 3 per cent." It suggests that the matter may be adjusted by paying a certain amount for the milk by weight without regard to its quality and a certain additional amount for each pound of butter fat it contains. Thus, if 30

cents per 100 pounds is paid for all milk and 10 cents a pound for butter fat, a milk with 3 per cent fat would bring 60 cents per 100 pounds; one with 4 per cent fat, 70 cents, etc. From later experiments (*R. 1891, p. 88*) it concludes that the payment according to fat content "gives substantially correct results."

For details of the method, see *Creameries* and *Milk tests*.

Cheese making.—The New York State Station has commenced quite extensive experiments to study the processes of cheese-making, accounts of which have thus far been published in *B. 37, n. ser., B. 43, n. ser., B. 45, n. ser., R. 1891, p. 220, 364*. These studies embrace the following subjects: Losses of milk constituents in cheese-making; effect of composition of milk on yield and composition of cheese; comparisons of Cheddar and stirred-curd processes, of commercial and homemade rennet extract, and of using different amounts of rennet; and the changes taking place in the ripening of cheese. The investigations are still in progress and no definite conclusions are attempted as yet. Some of the indications from the experiments thus far are as follows: The amount of fat lost in the whey per 100 pounds of milk was fairly uniform under like conditions of manufacture and seemed not to be influenced to any great extent by the percentage of fat in the milk. This loss was in general between $\frac{1}{4}$ and $\frac{1}{3}$ of a pound of fat per 100 pounds of milk. From 23 to 24 per cent of the casein and albumen in the milk was lost in the whey. The yield of cheese appeared to be considerably influenced by the percentage of fat in the milk increasing generally as the percentage of fat in the milk increased, although not uniformly. An increase of casein and albumen in the milk was generally accompanied by a slight increase in the yield of cheese and an increase in the amount of casein and albumen recovered in the cheese per 100 pounds of milk. The amount of water retained in the cheese was quite variable and generally increased when either the fat or casein and albumen in the milk increased; that is, a part of the increased yield was due to water. During May 11.4 pounds of cheese-factory milk or 8 8 pounds of the station milk was required to make 1 pound of cheese, and during June 10.1 pounds of factory milk or 9.76 pounds of station milk. In general the fat in the milk exercised a greater influence upon the composition of the cheese than any other constituent of the milk. The proportion of fat in the cheese increased as a rule when the percentage of fat in the milk increased, but this increase was not proportional to the increased fat content of the milk. The effect of a change in the proportion of casein and albumen in the milk was less marked, although the percentage of casein and albumen in the cheese generally increased when the milk was skimmed, and decreased when cream was added to the whole milk.

The results of analyses by Goessmann in 1875 (*Mass. State R. 1891, p. 337*) of cheese made from whole milk and from milk skimmed after standing 12, 24, 36, and 48 hours showed that as the percentage of fat in the milk diminished, the percentage of total solids and of fat in the cheese decreased regularly, while the curd increased. Experiments at the Minnesota Station (*B. 19*), using milk containing from 3.5 to 5.4 per cent of fat, confirmed the results at the New York State Station as to the effect of the percentage of fat in the milk on the loss of fat in the whey and the yield of cheese, showing that the loss was apparently independent of the percentage of fat in the whole milk and that in these trials the yield of green cheese increased as the percentage of fat in the milk increased. The percentage of fat in the whey was a little less than 0.4. The addition of cream to milk, giving mixtures containing 5.4 to 6 per cent of fat, involved no additional loss of fat in the whey, although there was a small increased loss of fat in pressing the cream cheese.

The Vermont Station (*R. 1891, p. 88*) reports trials of making cheese from milk with 3, 4, and 5 per cent of fat, respectively. The per cent of fat in the whey from these trials was 0.17, 0.25, and 0.3, respectively, and the loss of casein and albumen amounted to about one-fourth of the amount in the milk. The cheese from the 3 per cent milk was rated by commission merchants as poorest; that from milk with 4 and

5 per cent of fat was rated as about equal in quality and worth 1 cent per pound more than the other. The station concludes that "rich milk containing much over 4 per cent of fat can be more profitably made into butter than into cheese."

The same station has calculated from its experiments the distribution of the ingredients of milk in cheese-making, with the following result:

Distribution of ingredients in cheese-making.

	Total solids.	Fat.	Casein and albumen.	Milk sugar.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cheese	54.2	90.6	77.4	5.0	36
Cheese-press drips	0.9	0.4	0.6	1.5	1
Whey	44.9	9.0	22.0	93.5	63
	100	100	100	100	100

It has also calculated the average distribution of fertilizing ingredients in making cheese from 1,000 pounds of milk as follows:

Distribution of fertilizing ingredients in cheese-making.

	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*
1,000 pounds of whole milk	5.30	1.90	1.75
900 pounds of whey	1.35	1.23	1.63
100 pounds of cheese	3.95	0.65	0.12

It will be seen that a large proportion of the nitrogen goes into the cheese. Valuing the fertilizing ingredients at the average prices in commercial fertilizers "the total fertilizing value of the milk for a year from a dairy of 20 cows giving 4,000 pounds of milk apiece, will approximate $86.80, two-thirds ($56.80, of which is lost to the farm if cheese is sold and whey retained." See also *Ga. B. 18; N. H. B. 9; Tex. B. 5.* For cost of cheese per pound see *Cows, tests of dairy breeds.*

Chemistry.—The science of chemistry has been of the greatest service in explaining the laws of animal and plant nutrition, the physiology of plants and animals, the economic use of fertilizers and feeding stuffs, and in short in elaborating the theories which now prevail in the various branches of agricultural science. The development of agricultural science is due in a larger measure to chemistry than to any other single science. With this development has grown up a special branch of chemistry known as agricultural chemistry, as distinguished from general chemistry. The total number of chemists engaged in station work is 115, distributed among 52 stations. The chemists have an organization called the Association of Official Agricultural Chemists, which meets annually and decides upon methods of analysis for the ensuing year. This Association also carries on coöperative studies of methods of analysis during the year.

The work of the station chemists covers a very broad field and consists of analyses of feeding stuffs, fertilizers, plants, soils, milk and dairy products, and materials of every description; studies of the growth of plants, the ripening of fruit, the best time for harvesting crops for feeding, and the preservation of crops; digestion experiments, feeding experiments with various farm animals, field experiments in some cases, and other more strictly scientific investigations. The station chemists have been instrumental in pointing out the injustice of paying for milk at cream-

eries and cheese factories on the basis of the volume or weight of milk or cream without regard to its composition, and have devised several new methods for rapidly testing milk, which have found wide application. They have also done much valuable work in improving methods of analysis and devising laboratory apparatus.

Cherimoyer (*Anona cherimolia*).—This fruit, related to the custard apple and sometimes called by that name, thrives in a few sheltered localities in California (*Cal. R. 1880, p. 67, R. 1882, p. 106*).

Cherry.—Varieties of common cherries (*Prunus cerasus, P. avium*) have been quite generally planted in the experiment orchards of the stations. Such plantations are noted in *Cal. R. 1888–'89, pp. 86, 108, 137, 184, R. 1890, p. 269; Colo. R. 1890, p. 199; Ga. B. 11; Ind. B. 10; Iowa B. 2; Me. R. 1889, p. 255; Mass. Hatch B. 4; Mich. B. 55, B. 67, B. 80; Mo. College B. 10, B. 26; N. Y. State R. 1889, p. 352, R. 1890, p. 347; N. C. B. 72; Ohio R. 1883, p. 147; R. I. B. 7; Tenn. B. vol. III, 5, B. vol. V, 1, R. 1888, p. 12; Tex. B. 8, B. 16; Vt. R. 1888, p. 117, R. 1889, p. 121; Va. B. 2.*

In 1882 Prof. Budd, of the Iowa Station, studied the cherries of Europe on the ground from east France to the Volga in Russia, and the next spring one-year-old trees were imported of the varieties which appeared most promising for the Northwest. In *Iowa B. 2* descriptions are given of varieties which after severe testing during unfavorable summers and winters were still found promising, numbering 26 for northern Iowa, with 8 others for the southern part of the State. These varieties were more or less distributed among other Northern stations. In *Mich. B. 67* and *B. 80*, respectively, 43 and 49 varieties are named and in a general way classified as sweet or Mazard cherries, including Bigerreaus from *P. avium*, and Dukes and Morellos from *P. cerasus*, with Russian varieties of species undetermined. Descriptive notes are given on a considerable number of varieties. The sweet varieties are comparatively little grown in the State, though generally hardy in the southern part.

In *Iowa B. 10* the subject of stocks for the cherry, as also for some other fruits, is discussed at some length. Evidence is adduced that the Mahaleb stock, which is represented to be very widely used for all varieties through the North, really fails to unite with their wood. There is at first a growth from mere contact of cells, but unless the scion itself roots the growth soon fails. The common varieties on the other hand unite with the Mazard stock, but this can only be used in Iowa by crown-grafting and planting down to the top bud. Directions are given for successful crown-grafting with the cherry. Morello stock and the wild cherry (*P. pennsylvanica*) are commended.

The sand cherry of the Northwest (*P. pumila*) had been found, contrary to what might be supposed, an upright and rapid grower, and as easily worked as the Mahaleb. The work was still in the experimental stage, but it was found to unite well with hardy sorts and not to dwarf them during five years to a greater extent than does the Mahaleb. In *Iowa B. 2* deep setting of stocks and heading low are advocated; root-grafting is urged as far better than propagation by budding; late grafting is shown to be successful if the wood of the stock and that of the scion are in the same condition, and the plan of alternating rows of different varieties to insure pollination is favored.

The sand cherry, according to Prof. Bailey (*N. Y. Cornell B. 38*), includes three different forms, all perhaps species. The first is *P. pumila*, a prostrate or decumbent shrub, with straggling branches 3 or 4 feet high common in the Northern States; the second, *P. cuneata*, is of an erect habit, much more rare, reaching west to Minnesota; the third belongs to the plains and Rocky Mountains, and differs from the ordinary *P. pumila*, but is little known and no botanical name is assigned. The first two are grown for ornament and the first and third are receiving attention for their fruit. The first is considered in this view in *Minn. B. 18* and *S. Dak. B. 23* and *B. 26*, where it is described and looked upon quite hopefully as a subject for improvement, especially to meet the want of a perfectly hardy fruit for the Northwest. The fruit is very abundant, sometimes three-fourths of an inch in diameter, variable in color from

red to black, and in quality from astringent to insipid. The sand cherry is also noted in *Nebr. B. 18*, the plant here meant being, according to Prof. Bailey, the Rocky Mountain variety or species. This would seem to be still more promising than the other. "It is now in cultivation as the Improved Rocky Mountain Cherry." The *P. pumila*, as noted above, is looked upon favorably by the Iowa Station as a grafting stock.

The Utah Hybrid cherry is a fruit of uncertain value and doubtful affinity. Two varieties, the black and red, are in cultivation. It probably comes from some part of the Western plains or the Rocky Mountain region, but its wild prototype is unknown (*N. Y. Cornell B. 38*).

The wild black cherry (*P. serotina*) receives favorable notice from several of the stations for ornamental and forestry planting. Its wood is of a light red color, deepening with age, is close-grained, and well known among cabinetmakers and manufacturers of furniture, and the bark and roots have a medicinal value. In *Minn. B. 24* it is considered as pretty at all times and especially so when in blossom or when loaded with ripe fruit. It is very hardy in that State when grouped with other trees, and yields next to black walnut the most valuable wood there grown. In *Cal. R. 1880, p. 68*, it is noted as a beautiful and fast-growing tree, suitable to be planted in gardens and as an avenue and timber tree. Plantations at the South Dakota Station (*B. 12, B. 20,B. 29*) are noted in a favorable light.

The wild red cherry (*P. pennsylvanica*), growing in Wisconsin and eastward, as above noted, has been considered at the Iowa Station as a stock for grafting cultivated cherries (*Iowa B. 10*). It is mentioned (*Minn. B. 24*) as "a small native tree of good form and habit that does well under cultivation."

The chokecherry of the East is *P. virginiana*, a shrub or small tree with very astringent fruit of no horticultural interest. The plant so called in Nebraska is the *P. demissa*, the "Western chokecherry," or the "dwarf wild cherry," noted in *Nebr. B. 18* and *N. Y. Cornell B. 38*. "This shrubby plant promises to become important for its excellent cherries. They are often as large as the smallest of our cultivated cherries, and have an agreeable taste, closely resembling that of the wild black cherry." They are free from the astringency of the chokecherry, pleasant in the raw state, and used by the settlers for pastry, jellies, etc.

The Eastern chokecherry is mentioned in *Minn. B. 24* as a small native tree that does well under cultivation. An attempt to use it in a forestry plantation with larger trees to complete the shade is noted in *S. Dak. B. 29*.

The ground cherry is a herbaceous plant, for which see *Physalis*.

Cherry aphis.—See *Plant lice*.

Cherry, leaf spot (*Cylindrosporium padi*).—A fungous disease which attacks the leaves of cherry, plum, and peach trees, causing them to fall prematurely. It seems to be especially destructive in newly planted orchards. About the middle of May in the nursery, reddish spots make their appearance upon the upper side of the leaf. Upon the older trees their appearance is a month or more later. At first the spots are very small; later they become an eighth of an inch or more across, and by the blending of several a larger spot is formed. In a short time the spots turn brown, the leaves become yellow and fall, often nearly or quite prematurely denuding the tree. Upon the lower side of the leaf, opposite a spot on the upper side, may be seen an elevated area of a yellowish color, or whitish on the border, if it be ruptured. No experiments in treatment are reported, but the use of any of the more common fungicides would probably prove beneficial. (*Iowa B. 13.*)

Cherry, black knot.—See *Plum, black knot*.

Cherry, brown rot.—See *Plum, brown rot*.

Cherry slug (*Selandria cerasi*).—This slug is the larva of a small jet-black sawfly. The slug is about two-thirds of an inch long, dark green, and slimy. It eats the leaves of cherry, pear, and other trees, sometimes almost defoliating them. There are usually

two broods each season. It can be destroyed by the use of arsenites, pyrethrum, white hellebore, tobacco infusion, or air-slaked lime. The mature grubs may be caught by jarring them from the tree in early morning or late evening. (*Me. R. 1888, p. 176; Nev. B. 10; Ohio B. vol. II, 6; Ore. B. 5, B. 18.*)

Cheshire pigs.—See *Pigs, breeds.*

Chess.—See *Weeds.*

Chester White pigs.—See *Pigs, breeds.*

Chestnut (*Castanea* spp.).—American and foreign varieties have been planted for trial at several stations, chiefly as nut but also as timber trees. Some study has been given to the economic value of the tree and its fruit, and the advisability and method of cultivation. Plantations are noted in *Cal. R. 1880, p. 67, R. 1882, p. 102, R. 1885-'86, p. 120, R. 1888-'89, pp. 87, 196; Fla. B. 1; La. B. 22, B. 8 (2d. ser.); Mich. B. 55, B. 67, B. 80; R. I. B. 7; S. Dak. B. 8, B. 12.* Some comparison of varieties is made in *Pa. B. 16.*

Besides the native chestnut, from which a very few varieties have been developed, the European form of the same species (*C. vesca*), known as Spanish and Italian chestnut, has been introduced, as well as the Japanese chestnut. The latter has been planted especially in California, but also at the Florida, Michigan, and Rhode Island Stations. It is a dwarf tree, suited for hedges rather than independent growth, but yielding a nut which is larger than the largest Italian chestnut and bearing in four or five years from planting. At the Florida Station it was found to grow luxuriantly, doing better than the European chestnuts. It appears not to be hardy very far north. Attention is called by the California Station to the fact that the Italian chestnut, like many other trees from South Europe, is far better adapted to the climate of the State than its related species of the Eastern States. (See also *Chinkapin.*)

The composition of chestnuts has been somewhat studied at the Pennsylvania Station (*B. 16*). Analyses were made of 8 samples from European and native stock, with which are given some foreign analyses of these and other nuts, and of wheat, corn, and beans (see *Appendix, Table III*). General conclusions are that chestnuts are starchy rather than oily nuts, the European closely approaching wheat in composition; that the uncultivated American chestnut is more oily than the European and contains less starch; that European varieties grown in our climate, "though carefully cultivated and attaining normal size, apparently tend to become more oily, poorer in carbohydrates, and possibly less albuminous." On the other hand the nuts of "Moon Seedling" from American stock closely resemble in composition those from seedlings of European origin. Data relating to the food value and actual use of the chestnut are also given. Analyses of chestnut wood and bark (as also of those of other trees) are presented in *Ga. B. 2* (see *Appendix, Table V*). (See also *Mass. State R. 1891, p. 319.*)

In *Pa. B. 16* the subject of chestnut culture is somewhat fully discussed. It is believed that upon appropriate gravelly or sandy soils the cultivated chestnut may become by proper attention an important source of revenue as the native product already is in some measure. The value of the wood as well as of the fruit is noted. Directions are given for the treatment of the land and in general for raising the trees. The advantages of grafting in gaining time and securing fruit of a known character are noted, and a method of culture recommended. *Ala. College B. 3, n. ser.*, contains a general account of the chestnut from the economic point of view. A method of keeping the nuts in good condition is described. The chestnut has been planted for forestry purposes at the South Dakota Station with results not yet reported.

Chicken corn (*Sorghum vulgare* var.).—An annual non-saccharine variety of sorghum, each stalk of which bears one or more heads. It has become naturalized in the prairie region of Alabama and Mississippi and there grows wild. It pro-

duces a large amount of forage, which should be cut before the heads appear. The seed, which resembles that of the saccharine varieties of sorghum, has considerable value as a concentrated carbonaceous feeding stuff. After a crop of grain a dense growth of chicken corn springs up voluntarily. This affords one or more cuttings of hay.

Chicken corn is a troublesome weed in localities where it grows wild. It is especially partial to corn fields where the seed of the year before is usually in the ground. It will spring up after the last cultivation in the summer and make a rapid growth, remaining green until frost. Chicken corn is a suitable crop for the silo. (*Ala. Canebrake B. 9; Miss. B. 8, B. 20.*)

Chickens.—See *Poultry.*

Chick-pea (*Cicer arietinum*).—This is described in *Cal. B. 76* as the "species which is so highly esteemed in France and other countries of southern Europe for the same purpose as the lentil." "It is the basis of the *puree aux croutons,* so popular in Paris." One or more varieties of the chick-pea are known as *Chuna,* which see. (See also *N. Y. State R. 1883, p. 198.*)

Chickweed.—See *Weeds.*

Chicory (*Cichorium intybus*).—Five varieties of chicory were tested at the New York State Station (*R. 1884, p. 286*), including the Whitloof or large-rooted Brussels. Germination tests of chicory seed are on record in *N. Y. R. 1883, p. 68* (of Whitloof, *p. 71*), and *Vt. R. 1889, p. 104.*

China tree (*Melia azedarach*).—This tree, planted for ornament in the South, is briefly noted in *Ala. College B. 2, n. ser.* "The wood makes excellent furniture." The leaves, bark, and fruit have medicinal properties. The fruit, called China berries, was analyzed at the South Carolina Station (*R. 1889, p. 150*) with reference to its food and fertilizing ingredients (see *Appendix, Table III*). Horses have been observed to eat these berries voraciously, and, as the analysis shows them to be nutritious and the nutrients appear to be in good condition for digestion, it is judged that if no evil is found to result from continuously feeding them they may become an important adjunct to the feeding stuffs of the country.

Chinch bug (*Blissus leucopterus*).—This insect is more or less known throughout the entire country and the losses occasioned by it are sometimes very great. It spends the winter in a mature state under fallen grass or rubbish and appears again with the warm spring days. The female lays about 500 eggs upon the roots of wheat or some other plant. These soon hatch and the larva resembles the adult except in size and in having no wings. The adult insect is about one-seventh inch long, body black with white wings, each having a black spot about the middle. The young is at first yellow but becomes orange and then red. After molting a few times it has the size and wings of the adult. There are usually two, sometimes three broods in a season. The chinch bug has a peculiar odor. It feeds almost entirely upon cereals and grasses. It thrives best in hot, dry seasons. Protracted dampness is fatal to it, for at such times a plant parasite kills it off in great numbers and with great rapidity. At the Kansas Station for Experiments with Contagious Diseases of the Chinch Bug (*R. 1891*) investigations relating to various bacterial and fungous diseases show that certain of these diseases, especially the white fungus infection (*Sporotrichum globuliferum*), may be artificially introduced into fields infested with chinch bugs, with highly beneficial results during the months of the year (March-October) when the bugs are active. The destruction of the bug is rapid and effective. Kerosene emulsion where used has proved very effective. Burning and rolling them is often resorted to and when on the march trenches and boards set in the ground and covered with tar or kerosene will stop them. As they are sucking insects poisons have no effect on them. (*Ark. R. 1889, p. 158; Ill. B. 19; Iowa R. 1888, p. 11; Kans. R. 1888, p. 55; Minn. R. 1888, p. 350; Miss. R. 1891, p. 34; Ohio B. vol. III, 11, R. 1888, p. 164; S. C. R. 1888, p. 19.*)

Chinch bug, false (*Nysius angustatus*).—This insect resembles the true chinch bug in size and odor only. It is of a rather uniform brown color and does not have the white wings bearing the black spot. It seems to choose the plants of the mustard family, being worst upon radishes and turnips. Spraying with kerosene emulsion will kill this pest. (*Colo. B. 6, R. 1888, p. 100; Iowa B. 12, B. 15; S. Dak. B. 22.*)

Chinkapin (*Castanea pumila*).—This is a dwarf species of the chestnut, native southward in the United States. The small acorn-like nut is single in the bur. The shrub has been recently planted for trial at the Michigan Station (*B. 67, B. 80*). It was planted unsuccessfully at the New Mexico Station. The bark is noted (*Ala. College B. 3, n. ser.*) as used in medicine as an astringent and tonic in intermittent fevers.

Chirimoya.—See *Cherimoyer.*

Chorogi.—Under its Japanese name an illustrated account is given in *N. Y. Cornell B. 37* of the Japanese and Chinese vegetable *Stachys sieboldii* (otherwise called *S. tuberifera* and *S. affinis*), introduced in recent times into Europe and this country. Other names proposed are the *Crosnes du Japon*, Chinese or Japanese artichoke, etc. It is a small perennial plant of the mint family, with the aspect of peppermint or spearmint. It produces an abundance of small tubers, which can be eaten raw or fried, roasted, baked, pickled, preserved, stewed in cream, etc. The greatest fault with the vegetable is the fact that the tubers shrivel and spoil if exposed to the air for a few hours, but they can be kept in earth. The French market them in moist shavings or sawdust. This and further information is given in the bulletin above referred to, and various testimonies concerning the plant are collated. It is estimated to be an important addition to our list of secondary vegetables. Several foreign analyses and one made at Cornell are given (see *Appendix, Table III*). "All these analyses show that the chorogi rates fully as high as potatoes in food and fertilizer value."

Chokecherry.—See *Cherry.*

Chrysanthemum.—In *Ind. B. 20* is given a record of the process used and the results attained in an attempt to produce new varieties of this flower. White and deep crimson flowers were used and several new colors and heads of increased size were obtained. An experiment showed that pollen kept in a dry place would retain its vitality for five days, making it possible to send it by mail for use in crossing.

Chufa (*Cyperus esculentus*).—"The Spanish name for a ground rush nut that is really a noxious weed in every low, damp place on the college farm. The cultivated variety is a very fine-flavored edible nut when well dried or parched. For hogs it is said to be an excellent food" (*N. Mex. B. 4*). The nut is an underground tuber. Chufas were planted at the Louisiana Station (*B. 27*) and "were a splendid success, giving a large yield, suggesting and proving themselves to be a splendid crop for hogs." At the Alabama College Station (*B. 16*) "half an acre of very thin, sandy land was planted in chufas in 1889 to be gathered by swine." A portion of the product was picked by hand and found to measure at the rate of 172 bushels per acre while green, or when dry, assuming a shrinkage of one third, 115.24 bushels. This plant is called "earth almond" in a California list (*R. 1889, p. 202*).

Chuna.—Under this name seeds of a plant used for coffee were received at the New Mexico Station from Mexico. It proved to be the brown and the white chick-pea (*Cicer arietinum*) of Europe, and when planted seemed to be quite prolific. A plant called chuna was planted at the Colorado Station (*R. 1890, p. 21*). In *Cal. B. 76* the chuna is described as a brown-seeded variety of chick-pea from India, eaten by the natives in curries, cakes, etc., and very fattening for cattle. (See also *Chick-pea.*)

Churning.—GENERAL PRINCIPLES.—The churning of cream to butter depends upon the fact that when cream is vigorously agitated for a time the globules of fat it contains unite by adhesion to form little irregular-shaped particles of butter. At first these are very small, and, like the globules themselves, can only be seen with a micro-

scope; but as the process goes on these particles increase in size until they are visible to the eye, when the churned cream is said to have grained or gathered. Churning then is a conglomeration of the globules of fat. Numerous theories have been advanced to explain the process. It was formerly supposed that the fat globules owed their shape and individuality to a thin coating of solid casein which surrounded the individual globules and prevented their running together. This theory was also supposed to account for the improved churning of sour cream over sweet cream, on the assumption that as a result of the souring the casein coating was dissolved, allowing the globules to unite with each other readily to form butter. For reasons which can not be entered into here, this theory has been abandoned by scientists. The theory which has replaced it has very strong scientific evidence in its favor. It is supposed that the globules in milk and cream, the fat of which is in a liquid state, are surrounded only by a thin layer of liquid milk serum; and it has been found that when cream is churned these globules, which are ordinarily circular and of regular outline, harden and assume irregular shapes, with angular, uneven outline. This change takes place in the large globules first, and does not take place in the smaller ones until the churning has gone on for some time. As a result of their irregular outline and of the agitation, the globules become attached to each other until lumps large enough to be seen are formed. It is thus that no change is preceptible in the cream until it has been churned for some time, and that soon after the first preceptible change the butter "comes" almost suddenly.

The change of the fat from a liquid to a solid condition is a result of the shaking and agitation and is analogous to the changes in the globules when milk is frozen. When milk is frozen the fat in the globules solidifies and the globules take on the irregular form assumed in churning, and a little agitation suffices to unite them to butter. The shaking in the one case does what the low temperature does in the other. The smallest globules remain liquid at the end of churning and can not be made to solidify by intense shaking. They are therefore lost in the buttermilk. In freezing, on the other hand, all of the globules, large and small, are solidified, and this has suggested the theory that the yield of butter might be increased by freezing the cream.

The favorable results from allowing cream to sour before churning are explained in this theory by the fact that the coagulated casein of the sour cream does not present as much resistance to the freedom of the globule as the liquid serum—that is, the capillary attraction of the fat globules is weakened as a result of the coagulation of the casein.

Temperature of churning.—It will be evident from what has been said that the temperature at which cream is churned will have much to do with the rapidity with which the butter "comes," and with the proportion of the globules which unite to form lumps—that is, the yield of butter from a given amount of fat in cream.

But it is impracticable to give any definite temperature which is the best under all conditions. For instance, it is generally believed that sweet cream requires to be churned at a lower temperature than sour cream to secure the best results. Insufficient experiments have been made to definitely settle the temperature to be used or even the range of temperature. A German authority places the temperature for sweet cream at between 52° and 53.5° F. and for sour cream at between 59 and 61° F. The New York State Station (*R. 1889, p. 207*) recommends a temperature of 58°–60° F. in summer and of 60°–64° in winter, although it cautions that this is only a general statement to which there are exceptions, and mentions cases in its own experience where 53°–56° F. has been required, and again where better results have been obtained by churning at 68°–70° F. until the first appearance of the butter and then lowering the temperature to 62°–64°. The same station (*R. 1891, p. 369*) found that advancing lactation was generally accompanied by an increase in the relative number and a diminution in the relative size of the fat globules; that accom-

panying this there was a general tendency toward an increase of temperature and of time required for churning; and that in a large number of cases there was an increased loss of fat in the skim milk. In the test of dairy breeds at the station the temperature used in churning was, Jerseys 62.3°; Holsteins, Guernseys, Ayrshires, and Holdernesses 63.3°–63.5°; and Devons 66.6° F. (*R. 1891, p. 316*).

The New Hampshire Station (*R. 1889, p. 39*) found that in three trials 60° F. gave a slightly better yield of butter than 64°. At the Vermont Station (*R. 1890, p. 110*) the yield of butter was larger from churning at 57° than at 67°, although the butter came much sooner at 67°.

The Texas Station (*B. 11*) found that when cotton seed or cotton-seed meal was fed in considerable quantity the temperature required for churning was raised in the case of sour cream from 4°–8° F. and of sweet cream 1°–3° F. above that required when neither of these was fed. When cotton seed or cotton-seed meal was fed heavily the most advantageous temperature for churning was 68°–75° F. and the time required was about forty minutes. When these feeds were fed exclusively the best temperature for churning was 73°–80° and the time required about thirty-three minutes.

Churns.—Comparatively little has been done at the stations in testing different kinds of churns. In general there seems to be a tendency to abandon the dasher churn for the box or barrel churns and between these little difference has been found. Comparisons at the Wisconsin Station (*R. 1885, p. 48*) of a rectangular, a barrel, and a dasher churn showed differences of less than 1 per cent of butter by the three churns, except in one instance. Comparisons at the New Hampshire Station (*B. 7*) showed very little difference between the butter yielded from three different churns. At the Vermont Station (*B. 27*) both box and barrel churns were tested, but there was no perceptible difference in their work. The average per cent of fat in buttermilk was 0.14 with the box churn and 0.13 with the barrel churn.

As to the amount of cream to be churned in a churn of given size, the Wisconsin Station (*R. 1888, pp. 120, 121*) found that as the quantity of cream was increased there was practically no difference in the relative yield of butter, but the time required for churning increased regularly and also the temperature at the end of churning. The last is a decided disadvantage, as it makes the butter softer and more difficult to handle. "If these items be taken into account there would have been less time required in making two churnings even if the time necessary for filling and emptying the churn be reckoned."

For an account of the butter extractor, a combination separator and churn, see *Butter extractor*.

(*Wis. R. 1885, p. 43; Ga. B. 18; Kans. R. 1888, p. 95.*)

Churning sweet and sour cream.—The idea of churning cream sweet is not new. Danish butter, which has a high reputation for quality, is largely made from sweet cream; but the practice has been objected to on the ground that the yield of butter is smaller than from sour cream, and that sweet-cream butter is of inferior flavor and keeping quality. On the other hand it is urged that it is a more convenient method of handling cream than to allow it to sour and that a more even quality of butter is produced, as the butter from sour cream may be injured or spoiled by mischievous bacteria which get into the cream (see *Fermentations of milk and cream*).

Following is a review of the work done by the stations on the subject:

The New Hampshire Station (*R. 1888, p. 54*) found that when the cream from the mixed milk of a herd was churned sweet the resulting buttermilk contained from 0.26 to 9.58 per cent of fat, and that the churning was more perfect between 50° and 55° F. than at a higher temperature. It was concluded "that sweet cream may be churned and nearly, if not quite, the maximum amount of butter obtained if the churning be done at a temperature of about 50°."

The West Virginia Station (*B. 6*) proposed to reduce the loss in churning sweet cream by running the buttermilk from it through the separator and churning the

cream thus obtained; and it claims to have brought the losses within very satisfactory limits. On an average of eight months at a creamery in its charge 3.95 pounds of sour cream or 3.74 pounds of sweet cream were required per pound of butter.

At the Illinois Station (*B. 9*) it was found that up to a certain point the yield of butter increased with the acidity of the cream, but beyond that point there was no increase in butter yield, while there was danger of injury to the quality of the butter. As between strongly acid cream and cream barely ripe in 20 trials the churn yielded from 1.09 to 18.28 per cent more butter with the former. The time required for churning the former was a little less than for the latter. The yield of butter from sweet cream churned at 55° was but little below that of sour cream churned at 60°. No fat could be recovered by the separator from the sweet-cream buttermilk. The Wisconsin Station (*R. 1888, p. 111*) showed that "the ripening of cream before churning increases the yield of butter from 15 to 20 per cent, provided both are churned in the same way," and that "ripening appears to have no marked influence upon the time of churning." No advantage was found from mixing sour cream with sweet cream for churning, the loss of fat from sweet cream being the same as if it was churned separately. The results of trials on this point at the Vermont Station (*R. 1890, p. 111*) were somewhat conflicting. When about ¼ per cent of lactic or acetic acid was added to sweet cream and churned immediately, the yield of butter was practically the same as from sour cream (*Wis. R. 1888, p. 118*). The Illinois Station (*B. 9*) found no advantage from increasing the acidity of barely ripened cream by adding acetic acid just before churning.

Trials at the New York State Station (*R. 1889, p. 206*) indicated that if sweet cream was churned at the same temperature as sour cream (62°) the loss was excessive, but if churned at 50°–54° F. "there was no further loss than with the same cream ripened."

The Iowa Station (*B. 8*) reports that when sweet-cream butter was made according to Prof. Myer's directions and the buttermilk run through the separator about 0.21 per cent more butter was secured from sweet cream than from ripened cream. The Texas Station (*B. 11*) secured equal amounts of butter from sweet and ripened cream. At the Delaware Station (*B. 9*) where this process was tested the percentage of fat in the whole milk recovered in the butter was about 93.3 with sour cream and 88.4 with sweet cream. The butter from the buttermilk was of poor quality. "The efficiency of the sour-cream process is 4.93 per cent higher than that of the sweet-cream process."

For quality of butter from sweet and sour cream see *Butter from sweet and sour cream*.

Churn tests.—See *Milk tests*.

Cicada (*Cicada septendecim*) [also called 17-year locust].—This well-known insect is remarkable on account of the length of time the larva spends in the ground—seventeen years in the North or thirteen years in the South. The adult lives about a month, eats little, and only damages the small twigs in which it deposits its eggs. If the insects are numerous the twigs and sometimes even small trees will be killed. The female usually selects twigs one-fourth inch in diameter (preferably of oak), thrusts the ovipositor through the bark, separating it from the wood, and lays a pair of eggs. The larvæ hatch out in about six weeks and drop to the ground, in which they live, feeding on the roots of trees, for periods of seventeen or thirteen years as the case may be, when they transform to the winged state and ascend to the surface. There are said to be twenty-two different broods in the United States, some of which overlap. Frequent "locust years" are likely to be the result. There seems to be no good means of destroying them. (*N. J. R. 1889, p. 270; Pa. R. 1889, p. 182.*)

Cinchona trees (*Cinchona spp.*).—Some planting tests have been made of cinchona or Peruvian bark trees at the California Station at Berkeley, and under its influence in other parts of the State, of which account is given in *Cal. R. 1879, p. 74*,

R. 1880, p. 64, R. 1882, p. 103, R. 1885-'86, p. 126, R. 1889, p. 9. A beginning was made with seed of four species and one hybrid received from India. The station labored under great disadvantages for lack of appliances and the cinchona is a very difficult tree to handle. Raising plants from seed was found difficult, but from those grown it was found feasible to propagate by cuttings. Tested in the open air the first winter 2 varieties were killed by frost, 2 were attacked by a fungoid disease, and 1 (*C. succirubra*) survived. Later it was found possible to maintain *C. officinalis* and a hybrid through the winter with some protection, but the cold wave of 1888 killed down all. As reported in *Cal. R. 1885-'86, p. 126,* trees of the red Peruvian bark (*C. succirubra*), not the hardiest species, were found flourishing on the hills near San Diego.

Cinnamon trees (*Cinnamomum* spp.).—Two Japanese species (*C. glaucum* and *C. sericeum*) were planted at the California Station. The former had been tried in the open air and appeared as hardy as the camphor tree, which it closely resembles, besides being almost as rapid a grower. It yields an inferior kind of cinnamon, classed with cassia bark.

Clay.—Clay is the material resulting from the decomposition and subsequent hydration of feldspathic rocks, such as gneiss and granite. It is essentially a hydrated silicate of alumina, and is found in nature in a comparatively pure state as kaolin porcelain clay containing 40 per cent of alumina, 46 per cent of silica, and 14 per cent of water. The material ordinarily known as clay is an impure kaolinite, being a mixture of this substance with sand, undecomposed rock, oxide of iron, organic matter, etc. The prominent features of clay are softness, firmness of texture, absorptive power, and plasticity. It derives its agricultural importance from its value as an absorbent for manures or other putrescent matter and from its peculiar action in soils.

Soils as a rule contain a comparatively small percentage of pure clay combined with a large percentage of sand (*N. J. R. 1888, p. 214*), although the fine clay-like material designated clay in mechanical soil analysis may often run as high as 50 per cent. There is, according to Hilgard, rarely 75 per cent of clay in the purest natural clays; 40 to 47 per cent in the heaviest clay soils; and 10 to 20 per cent in ordinary loams. The power of clay to absorb large amounts of water and assume a gelatinous condition enables a comparatively small amount to exert a powerful binding action on the particles of sand, thereby to a great extent modifying the physical condition and influencing the agricultural character of soils (*Conn. State R. 1887, p. 153; Amer. Jour. Sci., Oct., 1873, and Mar., 1874*). The extent to which the peculiar properties of clay are manifested in soils is, however, determined largely by the size of the particles of sand, etc., with which it is associated. A soil containing a large amount of fine silt or sand exhibits most of the characteristics of heavy or clayey soils when containing a proportion of clay which in a coarser textured soil would have little effect on its physical properties.

In all methods of mechanical soil analysis much pains is taken to determine as accurately as possible the proportion of this valuable ingredient of soils.

The principal fruit of the endeavors to perfect methods for this purpose in the United States has been the "churn elutriator" of Prof. E. W. Hilgard and the "beaker elutriation" method of Dr. T. B. Osborne (*Conn. State R. 1886, pp. 142, 150*), (see *Soils, analysis*).

Prof. Hilgard designates as clay the material remaining suspended in a 200 mm. column of water after twenty-four hours' sedimentation, the particles of which vary from 0.01–0 mm. in diameter. Prof. Whitney, on the other hand, gives as limits 0.005–0.0001, maintaining that the finest particles are still solid, compact masses, and that all the essential properties of clay can be explained on purely physical principles (*Md. R. 1891, p. 276; U. S. Weather Bureau B. No. 4*).

It is well known that soils containing any considerable amount of clay are retentive of moisture and hinder its circulation (*N. Y. State R. 1887, p. 103, R. 1888, p.*

194; Wis. R. 1890, p. 151). They manifest a tendency to "puddle" and form clods when improperly tilled (*Wis. R. 1891, p. 103*). Especially is this true when the lime is deficient (*Cal. R. 1882, p. 51*) and alkali abundant (*Cal. R. 1890, App.; N. J. R. 1890, p. 247*). The well-known beneficial action of lime on clay soils is explained by the power which this substance possesses of flocculating or rolling into balls the clay particles, thus opening the pores of the soil and permitting the free circulation of soil waters (*Amer. Jour Sci., Mar., 1873; N. J. R. 1890. p. 242*). Ammonia and the alkalies, on the other hand, break up these floccules of clay and tend to make the soil pasty and difficult to till (see *Alkali soils*).

Since clay is the result of the weathering of rocks we would expect the soils of regions of scanty rainfall to show a deficiency of this substance. Prof. Hilgard, of the California Station, as a result of extended studies of the soils of the United States points out (*U. S. Weather Bureau B. No. 3*) "that the soils of the Atlantic slope are prevalently loams, containing considerable clay, and even in the case of alluvial lands oftentimes very clayey or heavy, while the character of the soils of arid regions is predominantly sandy or silty, with but a small proportion of clay, unless derived directly or indirectly from preëxisting formations of clay or clay shales." Not only is the proportion of clay greater in soils of humid regions than in those of arid regions, but its distribution is very different. In the former case "the clay, becoming partially diffused in the rain water when a somewhat heavy fall occurs, percolates through the soil in that condition, and tends to accumulate in the subsoil, the result being that almost without exception the subsoils of the humid regions are very decidedly more clayey than the corresponding surface soils."

In arid regions, on the other hand, the soils are practically without subsoils, the limited proportion of clay which they contain being in most cases distributed uniformly throughout the soil to a great depth.

(*Ala. College B. 38, n. ser.; Conn. State R. 1886, p. 140, R. 1887, p. 144, R. 1888, p. 154; Ind. Purdue Univ. R. 1882, p. 248; Md. R. 1891, p. 276; N. J. R. 1888, p. 213, R. 1890, p. 242; N. Y. State R. 1887, p. 103, R. 1888, p. 194; S. C. R. 1889, pp. 13, 53, 64; Wis. R. 1890, p. 151, R. 1891, p. 103; Amer. Jour. Sci., Oct. and Nov., 1873, Mar., 1874; U. S. Weather Bureau B. 3, B. 4.*)

Climatology.—See *Meteorology*.

Clover (*Trifolium* spp.).—The most important species of clover are medium or common red clover (*T. pratense*), mammoth red or sapling clover (*T. medium*), crimson or scarlet clover (*T. incarnatum*), white clover (*T. repens*), and alsike clover (*T. hybridum*). Among species of minor importance are buffalo clover (*T. reflexum*), low hop clover (*T. procumbens*), Carolina clover (*T. carolinianum*), and running clover (*T. stoloniferum*). Other important plants closely related to the clovers are often spoken of as clover (see, for example, *Lespedeza*, *Melilotus*, and *Alfalfa*.)

These plants furnish a large amount of very nutritious forage. They are also prized as soil renovators. Their long and multitudinous roots penetrate deep into the soil, improving its drainage and friability. The clovers have also the power of assimilating some of the free nitrogen of the air, and thus store up a large amount of expensive fertilizing material, which is returned to the soil with the decay of the clover roots and stubble.

Owing to this power of appropriating nitrogen from the air, clovers do not require expensive nitrogenous fertilizers, but thrive when fertilized with cheaper mineral elements. When clover and grass are sown together, the effect of nitrogenous fertilizers has been to decrease the proportion of clover by stimulating the grass (*N. Y. State R. 1889, p. 280*). The forage of clover is highly nitrogenous and is capable of replacing in part the more expensive concentrated food stuffs, such as bran, linseed meal, and cotton-seed meal.

(*Ala. Canebrake B. 9; Conn. Storrs B. 5, B. 6, R. 1890, p. 9; Del. B. 5; Ill. B. 5, B. 15; Iowa B. 11, B. 13, B. 14; Ky. B. 6, R. 1888, p. 57; La. R. 1891, p. 11; Me. R. 1889, p. 166; Mass. State R. 1888, p. 114; Mich. B. 68, B. 77; Minn. B. 8, B. 12, R. 1888, p. 188; Miss. B. 20, R. 1889, p. 34, R. 1890, p. 33; Nebr. B. 6, B. 17, B. 19; Nev.*

R. 1890, p. 13; N. J. R. 1889, p. 127; N. Y. State B. 20 R. 1889, p. 280; N. C. B. 63, B. 73, R. 1888, p. 134, R. 1889, p. 84; Ore. B. 4; S. Dak. R. 1889, p. 26, R. 1890, p. 13; Tenn. R. 1886, p. 134; Tex. B. 4; Wyo. B. 1.)

RED CLOVER (*Trifolium pratense*).—A forage plant making a dense growth of 1 to 2 feet. Its short leaves are marked above with a pale three-angled spot. It is a biennial or perennial, according to locality. Red clover has been cultivated for centuries. It succeeds best in a temperate climate not deficient in moisture. In the central and eastern part of the United States it constitutes one of the most important hay crops. Though not generally grown in the Gulf States, it succeeds on the strong clay lands and black prairie soil of the South. It may be grown as far north as Minnesota, but frequently does not thrive in newly settled sections (*Minn. B. 12*). It has been successfully grown all over Nebraska, where it is recommended for early pasture as well as for hay and where it withstands drought (*Nebr. B. 12, B. 17*). It has proved valuable in South Dakota (*S. Dak. R. 1890, p. 13*). Most of the stations give favorable reports of this plant. In Nevada, however, without water the growth is light. As a green manure it is probably more extensively used in the United States than any other plant. It is also a valuable crop for soiling and for the silo.

Composition.—See *Appendix, Tables I and II.*

Culture.—Twenty pounds of seed per acre is the quantity usually recommended. The seed is frequently adulterated with weed seed. At the Mississippi Station light-colored and dark seed germinated alike in the ground. Clover is sown broadcast. In cold climates spring sowing is customary. The Connecticut Storrs Station recommends sowing after grain in the latter part of July, in order to secure an early crop the next season. In the South seeding in September or October and in February is successful. In Kentucky, seed sown between February 2 and March 1 nearly all germinated.

Red clover ripens about the same time as orchard grass, and hence these two plants are suitable for sowing together. Although timothy ripens from two to three weeks later than red clover, these two are frequently sown as a mixture (9 pounds of timothy seed and 6 pounds of clover) (*Ill. B. 15*). Studies of the root system of red clover grown at the Minnesota Station showed that the amount of roots and the depth to which they penetrate varies greatly, depending on the character of the land. In a favorable soil a plant one month old had a root extending 7 inches into the ground; at two months old it had reached a depth of 2 feet; at five months its length was 5 feet 8 inches. As the restorative value of clover depends largely on the amount of roots, it is important to drain clover land, thus securing the most perfect root development. The stand is better on drained than on undrained soils.

Manuring.—Experiments in New Jersey tend to show that in that State barnyard manure produces the heaviest yield, that a combination of superphosphate and muriate of potash gives good results, while plaster has given no increase (*N. J. R. 1889, p. 127*). For most localities plaster is generally recommended.

Harvesting.—Clover is usually cut just after full bloom, or when one head in three is brown. At the Illinois Station (*B. 5*) the yield of hay was heavier when cut while one-fifth of the heads were brown. The quality was better in the earlier stage than when three-fourths were brown. It is cut two or three times in a season, yielding from 2 to 4 tons of hay. The last crop is frequently threshed for seed. The seed is worth from 5 to 7 cents per pound and the yield of seed is from 300 to 500 pounds per acre (*N. C. B. 73*). In the South the fall-sown crop is first cut about the middle of May. In the North the first crop is seldom ready before the middle of June. Red clover hay should be cured in cocks and handled as little as possible.

The yield of hay at the Connecticut Storrs Station has been about 3½ tons per acre. In the Gulf States weeds more or less choke the growth of clover the second or third year unless they are prevented from seeding by frequent mowing.

On the black prairie lands of Alabama the yield has been as high as 7,200 pounds of hay per acre.

Rotation.—A New Jersey rotation is corn, sweet potatoes, clover and millet, and clover. Red clover may follow almost any crop. Its special value in a rotation is in furnishing a large amount of vegetable matter to the following crop (usually corn). A field is usually left in clover for two seasons, in the South frequently for three years.

(*Ala. Canebrake B. 9; Conn. Storrs R. 1890, p. 13; Colo. B. 2; Del. B. 5; Ill. B. 5; Iowa B. 11; Kans. R. 1884, p. 115; Ky. R. 1888, p. 57; La. R. 1891, p. 11; Me. R. 1889, p. 166; Mass. State R. 1888, p 112; Mich. B. 68, B. 77; Miss. R. 1889, p. 34, R. 1890, p. 33, B. 20; Nebr. B. 6, B. 12, 17; Nev. R. 1890, p. 13; N. J. R. 1888, p. 83, R. 1889, p. 127; N. C. B. 73; Ore. B. 4; S. Dak. R. 1889, p. 26, R. 1890, p. 13; Tenn. R. 1889, p. 8*).

Mammoth red clover (*Trifolium medium*).—A forage plant closely resembling common red clover except in size. Mammoth clover makes a larger and coarser growth and ripens a few weeks later than common red clover. Its heavy growth gives it a high manurial value. At the Illinois Station this plant gave a larger yield of hay than did red clover. In Minnesota the weights were practically identical. Ripening at the same season as timothy, it succeeds when sown with this grass. The growth being rank and the stems large, curing is frequently difficult. (*Ill. B. 5, B. 15; Mass. State R. 1889, p. 158; Mich. B. 77; Minn. B. 12*).

Composition.—See *Appendix, Tables I and II.*

Crimson clover (*Trifolium incarnatum*) [sometimes called Italian or German clover].—An annual forage plant growing from 1 to 2 feet high, with flower heads from 1½ to 2 inches long and of a bright crimson color. Though not generally grown in the North, it made a growth of 26 inches at the Maine Station. It thrives on soil too light for other clovers. In the South it is valuable on non-calcareous, sandy, or light clay soils. It affords early spring pasture and a good quality of hay and has much value as a green manure for light soils. Good silage has been made from crimson clover. It is largely used in Delaware as a green manure for orchards, and has been found valuable there in protecting and keeping clean apples beaten off by wind.

Composition.—Crimson clover is rich in fertilizing elements and in food constituents (see *Del. R. 1890, p. 36*).

Culture.—In Delaware crimson clover is sown in the latter part of July or during August. In the South the seed may be sown from August till the middle of September or even later in extreme southern latitudes. It is important that considerable growth should be made before winter. On the other hand, to obtain a good stand one must wait for a suitable season. The quantity of seed varies from 10 to 15 pounds per acre, sown broadcast. It is not necessary to prepare the land especially for the clover crop, but the seed may be sown in fields of cotton, corn, or vegetables immediately after the cultivation and without covering. If clover is the only crop a light brushing or rolling is in order. The seed may also be sown among the vines of a pea crop. Crimson clover begins its growth as the peas die, and these two renovating crops supply a very large amount of organic matter to the soil.

Failure to secure a stand of crimson clover is frequent, due sometimes to the seed and sometimes to the season. The newly germinated plants are easily killed by a scorching sun. On stubble land a catch may be secured by harrowing deeply and then sowing the seed and rolling or harrowing lightly.

Harvesting.—In Delaware crimson clover can be cut for hay or for silage early in May. In the South it blooms in April. A yield of from 1 to 2 tons of excellent hay may be secured from very thin land. The hay is taken off in time to allow the use of the field for other summer crops. In Delaware some farmers, while plowing under the green crop in orchards, so turn the furrows as to leave the heads of clover above ground. These heads bear seed and thus afford a stand the next year. In cutting for hay in orchards other farmers leave strips of uncut clover along the rows of trees. From these strips the seed is scattered for the next year's crop.

Growing seed of crimson clover is a profitable industry. The yield is from 5 to 15 bushels per acre, worth from $4 to $8 per bushel. The seeds sprout very easily and rains on the hay cause a heavy loss of seed from sprouting and subsequent shattering. Some growers have hulled from stacks with success.

Rotation.—Crimson clover may follow grain or grass as well as cultivated crops. After cultivated crops it usually makes a good catch with slight expense. Orchards on thin soils may be benefited by plowing in crimson clover for several years in succession. On rich soil and for some crops it is possible to incorporate too much organic matter with the soil. Crimson clover leaves the land in good condition for a crop of cotton, corn, or vegetables. It has been found an excellent substitute for nitrate of soda in growing sweet potatoes in Delaware.

(Del. B. 16, R. 1890, p. 36; Fla. B. 6; Ill. B. 15; La. R. 1891, p. 11; Me. R. 1889, p. 166; Miss. B. 20; N. J. R. 1891, p. 143; N. C. B. 73; Ore. B. 4; Tex. B. 4; Wyo. B. 1.)

WHITE CLOVER (*Trifolium repens*).—A low, creeping, perennial clover with a white bloom, valuable only for grazing. It is sometimes called Dutch clover, from its having been grown in Holland for a long time. It affords grazing early in the season. When in blossom it salivates horses, and hence is objectionable in pastures where horses graze.

It thrives best on moist, calcareous loams, and succeeds better than any other clover on soils containing iron (*N. C. B. 73*).

One acre requires 13 pounds of seed sown broadcast. It is best to sow white clover as part of a mixture. It is hardy, and in a closely-grazed pasture overruns more valuable plants. The Iowa Station recommends it for early summer and fall pasture, but advises that animals be kept off in midsummer drought. In Maine it grows 12 inches high. In Minnesota on dry land it affords good pasturage for only a few weeks in the spring and fall. In Nevada without water it failed.

The yield of seed is 200 to 300 pounds per acre, worth 10 to 12 cents per pound (*N. C. B. 73.*)

Composition.—See *Appendix, Tables I and II.*

(Iowa B. 11; Me. R. 1889, p. 166; Mich. B. 68; Minn. B. 12, R. 1888, p. 181; Miss. R. 1889, p. 35; Nebr. B. 6, B. 17; Nev. R. 1890, p. 14; N. C. B. 73; R. I. R. 1890, p. 156.)

ALSIKE CLOVER (*Trifolium hybridum*).—A forage plant growing about 2 feet high, with a pinkish white blossom. It is a perennial and thrives best in a cool climate. In Minnesota it has proved less valuable than red and mammoth clover. It grows well in Maine and in most of the Northern and Central States. It makes a lighter crop of hay than red clover. It is also a pasture plant and thrives when sown with the grasses. It prefers a moist soil. The Michigan Station recommends it for light sandy soils in that State. It has not succeeded well in the South. In a mixture on stiff clay soils in Michigan it was overrun in a few years by other plants. An acre requires 15 pounds of seed. The yield of seed is 200 to 300 pounds per acre (*N. C. B. 73*); the yield of hay varies greatly.

Composition.—See *Appendix, Tables I and II.*

(Ill. B. 15; Iowa B. 11; Kans. R. 1884, p. 112; La. R. 1891, p. 11; Me. R. 1889, p. 166; Mass. State R. 1889, p. 158; Mich. B. 54, B. 68, R. 1888, p. 41; Minn. B. 12, R. 1888, p. 180, Miss. R. 1889, p. 34; Nebr. B. 6, B. 17; Nev. R. 1890, p. 34; N. Y. State R. 1889, p. 280; Tex. B. 4.)

Clover rot (*Sclerotinia trifolium*).—A fungous disease so far reported only on the scarlet clover in this country, although in Europe its attacks are very bad on red and other clovers. Its presence is usually marked by the complete killing of the clover in patches 1 to 4 or more feet in diameter. In the fall the infected plants will be found badly wilted and upon examination of the stem near the ground there will be found small black bodies, varying in size from that of a turnip seed to a small pea, while inside the stems will be found the fungus threads to which these small black bodies are attached. In the spring from each of these small bodies will be found emerging a small mushroom-like body (usually about a half inch in length). This

is the fruiting form of the fungus, which, if detached, can live in the ground as well as on the clover. This fungus can lead a dual life, either wholly as a parasite on the living clover plant, or as a saprophyte on the decaying one, or even as both—as a parasite until the host is killed, afterward upon the decaying stems as a saprophyte. This two-fold nature of the fungus makes it very difficult to eradicate. Rotation of crops is the only effective remedy. (*Del. R. 1890, p. 84.*)

Clover rust (*Uromyces trifolii*).—The most important fungous disease affecting clovers. It is said to have come to us from South America by way of Europe, where its ravages are very severe. It infests the leaves, leaf stalks, and stems. In general appearance the spots of the rust are definite in outline, rather oblong, brown in color, and somewhat powdery on the surface. This rust passes through three stages in its life cycle. The first, the cluster cup stage, seems to be passed, at least for the most part, upon the white clover, where in minute cups are born myriads of orange-colored spores, through which it seems to go to the red clover where the two other phases are passed. These are commonly called the red and black rusts, but they are phases of the same. The first has been found upon the red clover, but not abundantly, while the others are common on it.

The red-rust phase is the most abundant, the cool damp weather of summer being best for its rapid spread. It is not abundant upon the first cutting of the red clover, but may be very plentiful upon the later cuttings or "aftermath," where from 5 to 20 per cent of the plants may be destroyed. It passes the winter by means of the black-rust spores, and it is very probable the filaments live from year to year in the tissues of the white clover. The application of fungicides to prevent this disease does not seem practicable. The burning over of an infected field in the fall would undoubtedly destroy many spores in the dead stalks and thus lessen the spread of the disease the next season. However, when a field becomes badly infested the best way would be to turn the clover under and plant some other crop for awhile. (*Conn. State R. 1889, p. 174, R. 1890, p. 98; Iowa B. 13; Mass. State R. 1891, p. 232; N. Y. Cornell B. 24; Vt. R. 1890, p. 143.*)

Clover-seed midge (*Cecidomyia leguminicola*).—The adult insect is a very small two-winged fly, which lays its eggs in the opening heads of the clover. The eggs hatch into an orange-colored maggot. This feeds upon the forming seed and usually destroys every one in the head. Clover fields infested by this insect may be recognized by the green and dwarfed appearance of the heads. Early mowing of the first crop, when the heads are just appearing, will give a subsequent crop between the broods of the midge and when the plants will be sufficiently advanced to withstand its attacks. If very badly infested, plowing under the clover is the only sure means of destroying this pest. (*Iowa B. 13; Ohio B. vol. IV, 2 R. 1888, p. 133.*)

Clover silage.—See *Silage.*

Cochran milk test.—See *Milk tests.*

Cockle.—See *Weeds.*

Cocklebur.—See *Weeds.*

Codling moth (*Carpocapsa pomonella*).—The adult insect is a small moth one-half inch across its wings. The fore wings are gray, crossed by wavy brown lines. Near the outer margin is a larger brown area blotched with bronze. The hind wings are light brown. It flies at twilight and night. The female lays about 50 eggs, usually singly, upon the blossom end of the young apple. Upon hatching, the minute worm bores its way into the apple. It increases in size rapidly, attaining its full size in ten or twelve days, when it is the pinkish-colored worm about three-fourths inch long seen so often in apples. It burrows around the core and eats a hole to the outside, usually upon the side of the apple. In about a month it leaves the apple by this hole and falls to the ground. It then usually seeks the trunk of the tree, up which it crawls a little way and in a crevice of the bark is transformed into an adult moth ready to lay eggs for a second brood. The round of the second brood is the

same except that the worms do not always leave the apples but spend the winter in them in the cellar or bins. The insect is a native of Europe, whence it was brought nearly a century ago, and is now to be found in every State where apples are grown. In addition to the apple it infests the pear, haw, and sometimes peach and plum. With care and attention the codling moth may be held in check by spraying the trees with Paris green or London purple, 1 pound to 200 gallons of water. The first application must be made within a day or two of the fall of the bloom from the trees. Two or three subsequent sprayings should be made at intervals of about ten days. In order to destroy any chance of a second brood bands of twisted straw, cloth, or carpet paper should be placed around the trees. Under these the larvæ will collect while undergoing their change to moths. If examined every week or ten days and all larvæ and cocoons destroyed there will be little danger from a second brood of the worms. (*Ark. R. 1889, p. 147; Colo. B. 6, B. 15; Del. B. 4, R. 1889, pp. 110, 122, 133; Iowa B. 7; Kans. R. 1888, p. 165; Ky. B. 40; Me. R. 1888, p. 172, R. 1889, p. 189; Mass. Hatch B. 12; Mich. B. 39, R. 1888, p. 89; Miss. B. 14; N. J. R. 1889, p. 292; N. Mex. B. 5; N. Y. State B. 35; Nev. B. 8; N. C. B. 78; Ohio B. vol. III, 11, R. 1888, p. 132; Ore. B. 3, B. 5, B. 18; S. C. R. 1888, p. 31; W. Va. R. 1890, p. 152.*)

Coffee plant.—A note in *Cal. R. 1890, p. 235*, indicates that coffee can not be successfully grown in California.

Colic in horses.—A treatise on the causes, symptoms, diagnosis, treatment, and prevention of different forms of colic in horses has been published by the Ohio Station (*B. vol. II, 2*). The author believes that "the real predisposing cause of colic or the real cause why horses suffer so much more frequently than other animals must be found in the exceedingly frequent occurrence of aneurisms in the anterior mesenteric artery." The aneurisms are caused by small worms (*Sclerostomum equinum* or *Strongylus armatus*). Such aneurisms were found in twenty out of twenty-one horses examined at the station. (See also *Ohio R. 1886, p. 296, R. 1888, p. 178.*)

Collards.—A vegetable noted in *N. C. B. 74* as "a tall-growing cabbage that does not make a hard head, in the absence of winter cabbage much grown in the South." It is deemed worthy of study and improvement, said to bleach very tender when bent down and covered with earth in winter, to have many varieties, and apparently to be more exempt from insect pests than any of the heading cabbages. Varieties were grown at the New York State Station (*R. 1885, p. 149*), concerning which it is remarked that "judging from the samples grown the name collards is a very indefinite term." A germination test of the seed is reported in *N. Y. State R. 1883, p. 68.*

Colorado potato beetle.—See *Potato beetle.*

Colorado Station, Fort Collins.—Organized under act of Congress February 21, 1888, as a department of the State Agricultural College. Substations have been established as follows: San Luis Valley at Monte Vista, Arkansas Valley at Rocky Ford, Divide at Table Rock. The staff consists of the president of the college, director and agriculturist, botanist and horticulturist, chemist, meteorologist and irrigation engineer, entomologist, secretary, assistant agriculturist, assistant horticulturist, assistant meteorologist, assistant irrigation engineer, assistant zoölogist and entomologist, stenographer, and superintendents of the several substations. Its principal lines of work are systematic botany, meteorology, field experiments with crops, testing of varieties of vegetables and fruits, entomology, and irrigation. Up to January 1, 1893, the station had published 4 annual reports and 22 bulletins. Revenue in 1892, $16,280.

Colostrum.—The milk secreted by cows or other animals immediately after the birth of the young. Analyses of colostrum have been reported in *N. Y. State R. 1882, p. 25; Vt. R. 1891, p. 104.* The Vermont Station gives the composition of the colostrum from the first four milkings after calving as compared with milk given three weeks later, as follows:

Composition of colostrum.

Average analyses.	Specific gravity.	Total solids (actual).	Total solids (calculated).	Fat.	Casein and albumen.	Milk sugar.	Ash.
Colostrum:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
First milking	1.0533	19.37	17.96	3.86	11.44	2.40	1.67
Second milking	1.0415	14.33	13.88	2.92	6.49	3.60	1.33
Third milking	1.0380	12.98	12.60	2.58	5.01	4.16	1.23
Fourth milking	1.0364	13.92	13.55	3.71	4.71	4.28	1.24
Milk (three weeks after calving)	1.0330	13.52	13.77	4.60	3.34	5.00	0.58

It will be seen that the colostrum is richer in casein, albumen, and ash, but poorer in fat and milk sugar than the milk given three weeks later.

COLOSTRUM BUTTER.—The same station found that colostrum creamed as perfectly as milk, and that the cream on being churned gave a butter differing in composition from ordinary butter mainly in containing more curd. The colostrum butter "was vividly yellow, had the acrid, disagreeable colostrum taste, and became rancid much more rapidly than milk butter."

Colts.—See *Horses and colts.*

Composite samples of milk.—See *Creameries.*

Compost.—Composting is a convenient means of supplementing and conserving the various manurial resources of the farm. The value of peat for composting with animal manures has long been understood. This value depends upon its power to absorb moisture and ammonia and to promote fermentation, whereby the availability of both the peat and the manure is increased.

The fermenting compost heap is also often used for the reduction of insoluble phosphates, such as floats and bone. In both these cases the desired results are brought about almost exclusively by the action of fermenting organic matter. There are various methods of composting in which practically the same changes are induced, largely, by purely chemical means. This is true of composts in which caustic alkaline carbonates are used as reducing agents. An example of this class is the compost of peat with salt and lime, which has long been a favorite, and which has been thoroughly investigated by the Connecticut State Station (*R. 1880, p. 58, R. 1883, p. 81*). A careful study of the action of several different decomposing agents on peat was made with the result of showing that lime slaked in brine (yielding by chemical reaction caustic soda and calcium chloride) is more effective in reducing this substance than either ashes or lime alone, and "where salt is cheap and wood ashes scarce the mixture may be applied accordingly to advantage." It is suggested that muriate of potash may be substituted for the salt, thereby securing, in addition to the desired decomposition of the peat, an increase of the potash in the resulting compost.

Numerous methods of composting and reducing bones have been proposed, of which the following are especially commendable:

"A trench about 3 feet deep should be dug and a 6-inch layer of ashes placed at the bottom, followed by a layer of whole bones of the same thickness; next a layer of ashes, then of bones, till all the bones are covered. Each layer should, as soon as put down, be saturated with water. Stakes should be set in the mass at the beginning 3 feet apart, and withdrawn in nine or ten days and water poured into the holes to again saturate the ashes. In about two months the mass is forked over and moistened again, when the bones will be found quite soft. After five months and about three forkings they will, under ordinary circumstances, be entirely decomposed."

Another plan somewhat similar is reported by Prof. Johnson as described by Ilienkoff, as follows: "To 4,000 pounds of bone take 4,000 pounds of unleached wood ashes, 600 pounds of fresh burned lime, and 4,500 pounds of water. First slake the lime to a powder and mix it with the ashes, and placing a layer of bones in a suitable receptacle—a pit in the ground lined with boards, stone slabs, or brick—cover them with the mixture; lay down more bones and cover, and repeat this until half the bone or 2,000 pounds are interstratified with the ashes and lime. Then pour on 3,600 pounds of water, distributing it well, and let it stand. From time to time add water to keep the mass moist. So soon as the bones have softened so that they can be crushed between the fingers to a soft, soap-like mass, take the other 2,000 pounds of bones and stratify them in another pit with the contents of the first. When the whole is soft shovel out to dry and finely mix with dry muck or loam (4,000 pounds, or enough to make it handle well).

"This product may be used directly on the land, or, which is better still, mixed with stable manure as in a regular compost in the proportions of 600 pounds stable manure, 800 pounds decomposed bones, and 600 pounds of rich earth. From 400 pounds upward, as desired, could be applied to each acre." (*N. C. B. 61.*)

The method of fermenting bones with ashes has been investigated by the New Hampshire Station (*R. 1888, p. 10*) as mentioned under *Ashes*.

Investigations by the Florida Station (*B. 7, B. 13*) have shown that the extensive bayheads and muck beds of that State "contain a superior quality of muck, which, with little expense or trouble, can be composted to be slightly inferior to a good grade of stable manure." Numerous formulas for composting this muck with stable manure, cotton seed, ashes, and various agricultural chemicals, are given in the bulletins.

The Georgia Station (*B. 15*) has conducted experiments on corn which lead to the conclusion "that there is nothing gained by previously mixing and fermenting stable manure, cotton seed (crushed), and superphosphate in the proportions given (346 lbs. each) in comparison with applying the same ingredients directly and separately to the soil."

The preparation of composts has received considerable attention by the North Carolina Station (*R. 1880, p. 119, R. 1881, p.* 105, *R. 1882, p. 79, R. 1885, p. 48, R. 1887, p. 56, B. 61*). In these publications the principles and practice of composting are very thoroughly discussed and numerous formulas and analyses are given showing how the various refuse fertilizing materials of the farm may be utilized to advantage.

(*Ala. College B. 8, B. 16; Conn. State R. 1880, pp. 58, 65, R. 1882, p. 70, R. 1883, p. 81; Fla. B. 7. B. 13; Ga. B. 15; N. C. B. 61, R. 1879, p. 59, R. 1880, p. 119, R. 1881, p. 105, R. 1882, p. 79, R. 1885, p. 48, R. 1887, p. 56.*)

Connecticut State Station, New Haven.—Organized under State authority at Middletown, October 1, 1875, as the first regularly organized station in the United States. Removed to New Haven in 1887 and reorganized under the same authority. Since the passage of the act of Congress of March 2, 1887, this station has annually received one-half of the appropriation granted to Connecticut under that act. The staff of the station consists of a director, vice-director and chemist, four chemists, meteorologist, grass agent, librarian and clerk, superintendent of buildings and grounds, and two laboratory assistants. Its principal lines of work are chemistry, including methods of analysis; analysis and inspection of fertilizers; field experiments with fertilizers; analysis of feeding stuffs; chemistry of milk and its products; and tests of forage plants. Up to January 1, 1893, the station had published 16 annual reports and 114 bulletins. Revenue in 1892, $18,799.

Connecticut Storrs Station, Storrs.—Organized March 29, 1888, under act of Congress of March 2, 1887, as a department of Storrs Agricultural School. The staff consists of the principal of the school, director, vice-director and chemist, agriculturist, assistant agriculturist, assistant chemist, and assistant in farm experiments. Its

principal lines of work are chemistry of foods and feeding stuffs, bacteriology of milk and its products, and field experiments with crops. The chemical work of the station is done in the laboratory of Wesleyan University at Middletown. Up to January 1, 1893, the station had published 5 annual reports and 9 bulletins. Revenue in 1892, $7,853.

Coolers for milk and cream.—See *Aërator.*

Cooley system of raising cream.—See *Creaming of milk.*

Copper compounds.—See *Fungicides.*

Cord grass.—See *Grasses.*

Cork oak.—See *Oak trees.*

Corn (*Zea mays*) [also called Maize].—See also *Brazilian flour corn, Pop corn,* and *Sweet corn.* This plant belongs to the grass family, and is distinguished by its pith-filled stalks, by its ears (ovaries) on the side of the stem, and by its large growth. The different varieties are classified as dent, flint, pop, soft, sweet, and pod (see *N. Y. State B. 60* for proposed classification). Only dent and flint varieties, which include all that are commonly grown in the United States as field crops, will be considered in this article. Numerous investigations on corn have been made at the stations and elsewhere, but much still remains to be done before a complete account of the life history and requirements of this plant can be given. The scope of this work permits only a fragmentary treatment of this subject.

The roots of numerous corn plants at different stages of growth were dug from a rich, sandy soil and examined at the Minnesota Station (*B. 5*). The results as published, with illustrations, show that in the spring, when the surface soil is comparatively warm, moist, and rich in plant food the roots start out nearly horizontally from the lowest joints of the stem and spread from 2 to 5 feet from the stalk, but as the upper soil grows dry they turn downward, attaining a length of from 3 to 8 feet or even more. The later roots from joints higher up are at first much larger in diameter than the earlier ones, but grow vertically downward and diminish in size. The larger diameter of these "brace roots" enables them to aid more effectively in keeping the stalk erect. Many of the earlier roots often die before the stalk ripens, leaving the later and larger roots to supply the plant with nourishment. The primary roots branch into numerous secondary roots which have their greatest development near the surface of the soil, so that the principal part of the root system is within a foot of the top of the ground.

The Illinois Station (*B. 4, B. 8, B. 13*) has found that depth of planting has little to do with the depth at which the roots grow. At the New York State Station (*R. 1888, p. 171*) on plats cultivated to depths of from one-half to 2½ feet more roots reached a depth of 2½ feet with the deep than with the shallow cultivation. The proportion of shallow roots was greatest on the shallow-worked plats. While there was abundant moisture in the soil the shallow-rooted plants did best, but when dry weather came on the deep-rooted plants became the more vigorous. At the end of the season the tallest and least mature plants were on the deepest-worked plats.

Notes on habits of growth of the stalk are given in *Minn. B. 5.* A tall and strong stalk usually develops from the seed, at the joints of which the leaves are formed. In the axils of the leaves buds are produced, though at many of the joints, especially in dent varieties these buds do not develop beyond the rudimentary stage. The buds from the lower joints may grow into more or less perfect stalks (tillers, stools, or suckers) with tassels and ears. One to several of the higher buds produce the female flowers from which the ears are developed. The branched tassel at the top of the stalk bears the male flowers. All sorts of oddities and monstrosities are produced by the irregular growth of the shoots from the buds on the stalk.

Observations on the leaves, tassels, silk, and pollen are reported in *Iowa B. 2* and *B. 7.* It was found that in different varieties there was considerable variation in the thickness of the leaf and in the amount and distribution of the green coloring

matter (chlorophyll). "The tassels and the silks of the primary ears appear generally about the same time. The upper central spikes of the tassels shed their pollen usually about twenty-four hours before the pollen of their lateral spikes is ready to fall. The first silks which protrude through the husks are from the lower ends of the ears. Usually twenty-four hours elapse before silks are in a receptive condition, after their first appearance. * * * When well grown the best corn for Iowa will not exceed $9\frac{1}{2}$ feet in height, its ears will be $3\frac{1}{2}$ feet from the ground, and each of its stalks will have 13 blades." Microscopical examinations indicated that in Livingston Leaming corn the pollen grains from the central spikes of the tassel were larger than those from the lateral spikes, the former averaging $\frac{12}{2500}$ of an inch and the latter $\frac{10}{2500}$.

At the New York Cornell Station (*B. 40*) it was found that "an average of six stalks gave 7.02 grams of anthers and 3.49 grams of pollen."

Measurements of leaves made at the Missouri Station (*B. 5*) gave a total leaf surface (including one side of the sheath) of 3,480 square inches on one plant taken July 9.

The kernels are described by Profs. Morrow and Hunt, of the Illinois and Ohio Stations, respectively, in *The Soils and Crops of the Farm*, as follows:

"The structure of the corn kernel is in general like that of the wheat kernel. There is the outer covering, which corresponds to the pod of the pea or edible part of the cherry. Inside there is the testa, or true seed coat, which contains the coloring matter and gives the kernel its color. Inside the testa is the row of irregular cubical cells, the so-called embryonic envelope. These cells are not so large as in the wheat. Inside this row of cells is the germ or embryo and the endosperm. The endosperm consists of thin walled cells of cellulose packed full of starch grains and very little nitrogenous material. In sweet corn instead of the cells of the endosperm being packed full of starch grains, the latter are changed to glucose, and the shrinking caused by the transformation makes the sweet-corn kernel wrinkled. * * *

"The types of corn are as follows:

"(1) Dent corn is that type in which the split kernel shows the germ, the glossy starch on each side, and the white starch extending to the top of the kernel. The kernel is indented on the top, evidently because the softer starch shrinks in the center, while the denser starch on the sides holds the sides in a straight line. The kernels of dent corn are more or less wedge-shaped.

"(2) Flint corn is that type in which the split kernel shows the germ, the white starch, and the glossy starch surrounding. The surrounding dense starch prevents the kernels from indenting. The kernels are hard, smooth, and more or less oval.

"(3) Pop corn is that type in which all, or almost all, the endosperm or starch is glossy. The kernel is an elongated oval in outline and extremely hard.

"(4) Soft corn is that type of corn in which the endosperm is entirely white. The shape of the kernel is similar to that of the flint corn, and the starch grains in the endosperm being loosely arranged the kernel is easily crushed.

"(5) Sweet corn is that type in which the endosperm is translucent and horny in appearance, the starch having been more or less reduced to glucose. The kernels are wedge-shaped and usually very much wrinkled. * * *

"A good ear of dent corn should be as nearly cylindrical as may be, so that it may hold the largest amount of corn in proportion to the size of the junction with the stalk. Ears that taper rapidly also have usually less corn in proportion to the cob. Both the tip and butt should be well filled.

"A good sized ear is 8 to 9 inches long and from $6\frac{1}{2}$ to 7 inches in circumference at two-fifths its length from the butt. Ten inches is rather long for an ear of dent corn, while 7 inches is a good length for smaller varieties. It is a good ear that weighs three-fourths of a pound. It takes about 100 good ears to make a bushel of shelled corn. A good size for the circumference of the cob is from $3\frac{5}{8}$ to $4\frac{1}{8}$ inches."

Illustrations of ears of corn of different varieties, showing the arrangement of the kernels on the cob, are given in *N. Y. State R. 1884, p. 425.*

Observations at the Pennsylvania Station (*R. 1888, p. 167*) showed that corn which was planted 1½ inches deep May 8, 1888, and sprouted May 22, grew from 1 to 4.7 inches each day from June 19 to August 3. In 1887 corn planted May 12 reached its average maximum height of 80 inches by July 23, a period of seventy-two days, during which there was a mean daily temperature of 70° F., a precipitation of 8.3 inches, thirty-one days on which rain fell, and a mean daily cloudiness of 4.2 on a scale of 10. In 1888 corn planted May 8 grew to 81 inches in height by August 8, ninety-two days, with a mean daily temperature of 67°, a precipitation of 11.5 inches falling on twenty-eight days, of which thirteen were before June 1, and a mean daily cloudiness of 4.9 on a scale of 10. Under these conditions temperature seems to be the controlling factor to determine the rate of the growth of corn. Reference is made to somewhat similar observations by Prof. Plumb (*Agricultural Science, vol. III, p. 1*). The New York State Station (*R. 1886, p. 42*) reports observations indicating that corn requires a high maximum as well as a high mean temperature of soil and air. The influence of local conditions of soil and climate on the corn plant are stated in *Kans. R. 1888, p. 23*, as follows:

"We have here almost universally the rich, deep, friable soil which the experience of all corn-growing communities has shown to be necessary to the perfect growth of the great staple. Moreover, here are the fervent summer heats and great length of growing season so well calculated to bring the corn plant in all its parts, leaf, stalk, and ear, to the greatest perfection. As a result of these natural influences the corn plant in Kansas assumes the largest proportions; the stalks are coarse and very tall, the leaves are broad and long, if not numerous, while the ear is large and lifted far above ground, often above the tassels of the small-growing sorts, as was shown in our experiments. Small-growing, dwarfish corn is never seen in Kansas, except in cases where the seed used or its immediate ancestors has been introduced from the North; and even these small-growing foreign sorts, when grown for a series of years in Kansas, tend rapidly toward the normal type. A variety of King Philip corn, grown on the college farm since 1876, and in this vicinity since 1872 or 1873, and kept pure meanwhile is no longer a flint corn, while in size and habit of growth it more nearly resembles a medium dent sort than the familiar New England variety from which it is descended."

Many observations have shown that there is relatively little dry matter in corn in its early stages (see *Ill. B. 20* and under *Time of cutting*, below). When the crop is mature about one-half the dry matter is in the ears. The leaves and husks contain one-fourth to one-third of the total dry matter, the stalk about one-fourth, and the cob nearly one-tenth. The butt of the stalk contains much more dry matter than the top (*Pa. B. 11; S. C. B. 8; Wis. R. 1889, p. 143, R. 1891, p. 220*).

VARIETIES.—Tests of varieties of corn have been made at about thirty of the stations. The following are among those which have been most productive varieties in different localities:

Dent varieties.—Yellow—Edmonds, Golden Beauty, Leaming, Legal Tender, Murdock, North Star, Piasa Queen, Riley Favorite. White—Blount Prolific, Burr White, Champion White Pearl, Mammoth White, Mosby Prolific, Normandy Giant, Southern Horse-Tooth.

Flint varieties.—Pride of the North, King Philip.

The Illinois Station (*B. 20*) makes the following general statements regarding its tests of varieties of corn:

"In 1891, 36 varieties were tested on 52 plats. About 86 per cent of a full stand of stalks was secured. About 12 per cent of the stalks produced no ears. This is nearly the same result as found in 1888 and 1890. In 1889 there was less than 2 per cent of barren stalks. While the percentage of stalks does not seem to depend on variety, there were great differences in different plats—from 3 to 29 per cent.

"As had been the case in each of the three preceding years, the varieties maturing about September 20 gave a larger average yield than those maturing either earlier

or later. In 1891, 13 early varieties averaged 56, 19 medium averaged 66, and 6 late-maturing varieties averaged 57 bushels of air-dry corn per acre. For the four years the early varieties gave an average yield of 61, the medium 73, and the late 68 bushels of air-dry corn.

"In some cases marked differences were found in the yield of adjacent plats of the same variety. In the case of one variety there have been extraordinary variations in yield in different years. In each of the four years varieties little known and without more than a neighborhood reputation have given large yields of good corn. The yield does not seem to depend on the color or the smoothness or roughness of the kernels, although in 1891 the white varieties gave an average of 4 bushels larger yield than the greater number of yellow varieties."

Tabulated data for 22 varieties grown at the Indiana Station (*B. 39*) during from two to five years showed important differences illustrating the need of careful selection of varieties by the farmer with reference to the conditions under which his crop is grown, as follows:

"(1) A range of twenty-eight days in the time of ripening; (2) a range in yield per acre of nearly 35 bushels of corn and almost 700 pounds of stalks; (3) a range of from 27.5 to 52.5 per cent in the proportion of ears to 100 pounds of stalks and ears; (4) a difference of nearly 4 per cent in the proportion of shelled corn to weight of ears; (5) a marked range in the amount of shrinkage in curing from 3.2 to 23 per cent; (6) striking differences in the per cent of smutted stalks that did not produce ears, the range being from nothing to 50 per cent."

(*Ala. Canebrake B. 7, B. 10; Ala. College B. 1, n. ser., B. 16, n. ser., B. 32, n. ser.; Ark. R. 1888, p. 120, R. 1889, p. 23, R. 1890, p. 6; Colo. R. 1889, p. 93, R. 1890, p. 206; Ga. B. 10, B. 15; Ill. B. 4, B. 8, B. 13, B. 20; Ind. B. 14, B. 23, B. 39; Iowa B. 2, B. 7; Kans. B. 30, R. 1888, p. 14, R. 1889, p. 6; La. B. 3, B. 21, B. 22, B. 26, B. 7, 2d ser., B. 8, 2d ser., R. 1891, p. 146; Md. R. 1889, p. 124; Mass. State R. 1889, p. 168; Minn. B. 7, B. 11, R. 1888, p. 90; Miss. R. 1889, p. 14, R. 1890, p. 20; Mo. College B. 3; Mo. B. 14; Nebr. B. 6, B. 12, B. 19; Nev. R. 1891, p. 14; N. H. B. 3; N. Y. Cornell B. 16; N. Y. State B. 60, R. 1882, p. 38, R. 1883, p. 130, R. 1884, p. 93, R. 1889, p. 71; Ohio B. 12, B. vol. II, 3, B. vol. III, 3, B. vol. IV, 1, R. 1882, p. 38, R. 1883, p. 53, R. 1884, p. 64, R. 1885, p. 23, R. 1886, p. 83, R. 1887, p. 113; Ore. B. 4; Pa. B. 7, B. 11, R. 1888, p. 26, R. 1889, p. 30, R. 1890, p. 30; S. C. R. 1886, R. 1888, p. 162, R. 1889, p. 210; S. Dak. B. 24, R. 1888, p. 32, R. 1890, p. 14; Tenn. B. vol. III, 2; Utah R. 1891, p. 59; Vt. R. 1889, p. 89, R. 1890, p. 153; Wis. B. 9, B. 13, B. 17, B. 19, R. 1889, p. 123.*)

CROSSING.—Since the wind often carries the pollen from one stalk to the silks of the ears of other stalks the offspring of different varieties grown on one farm or in one neighborhood is very likely to be of a mixed type. The ease with which varieties of corn can be cross-fertilized has led to numerous experiments with a view to determining the laws which control the mixing of varieties in order that we may better understand how to produce improved varieties. Many interesting facts have been brought out, but the results do not as yet admit of definite general conclusions.

At the Kansas Station (*B. 17, B. 27, R. 1888, p. 316, R. 1889, p. 288*) of the crosses made in 1889 to improve varieties 20 were harvested in 1891. Eight of these gave no indications of a cross. Of the remaining 12 some showed exactly intermediate characteristics between the parents and others resembled one parent more than the other. Of 43 crosses made in 1890 and harvested in 1891 eight showed no intermediate characteristics between the parents. Of this number 3 resembled the female parent, 2 the male parent, and 3 showed no resemblance to either parent. Twenty-five of the others showed intermediate characteristics, 5 in color, 10 in the character of the kernels, and 10 in both color and character of the kernels. In one case of a cross of the fourth year between Early White Dent and Golden Popcorn the uniformity of the ears produced indicated that the crosses had become a distinct variety. Some blue kernels found on ears of corn whose immediate parents were known to have shown no kernels of this color were planted and one of the resulting ears

was artificially fertilized with pollen from the same stalk under conditions which kept it free from any possible intermediate cross. This ear contained 370 kernels.

"Of these 206 were blue, 71 pink, 71 orange-yellow, and 22 pure white.

"This result seems to be conclusive evidence that the blue of the grains planted was the product of atavism, and from the fact that all the planted grains were blue, the pink, yellow, and white grains in like manner must have reverted to other varieties. Five other ears from the same seed, but not inclosed—thus being exposed to the pollen of other varieties—showed the same variation in color with a slightly smaller per cent of blue.

"To show the prepotency of the blue corn a large number of ears from other plats growing within a radius of 25 yards were examined. About half the number of uninclosed ears had from one to five blue kernels, while not one of the inclosed gave any traces of blue."

Descriptions and illustrations of the several crossed ears obtained in these experiments are given in the reports. In illustrated accounts of similar experiments at the Minnesota Station (*B. 7, B. 11*) interesting data are given. The tendency to revert to more or less remote ancestors was also strikingly shown at this station. The Illinois Station (*B. 21*) has recently published an illustrated account of experiments in 1889 and 1890. In these experiments color tended very strongly to pass from one variety to another. The number of rows of kernels seemed to be modified about equally by each parent. There was a tendency to increase in size. Crossed corn of the second year was uniform in type when the parents were similar, but where they were widely dissimilar, as in crosses between sweet and dent varieties, the offspring either reverted to the parent forms or was dissimilar to either parent. (*Ind. B. 20; N. Y. State B. 15, B. 46, B. 55, B. 72, R. 1882, p. 38; Ohio R. 1883, p. 63.*)

COMPOSITION.—For average analyses of the whole plant, stover, ears, kernels, dry fodder, silage, etc., see *Appendix, Tables I and II.* For detailed analyses of varieties, etc., see *Bulletin No. 11* of the Office of Experiment Stations. Special investigations are recorded as follows: Effect of rate of planting on composition of crop (*Conn. State R. 1889, p. 9*); effect of different fertilizers (*Conn. Storrs R. 1889, p. 87, R. 1890, p. 107*); composition at different stages of growth (*Mo. B. 9*); fertilizing constituents (*S. C. B. 8*): corn from seed grown in several States (*Tex. B. 15*); whole plant and parts (*S. C. R. 1889, p. 156*). See also Reports of Massachusetts State and Connecticut State Stations.

SEED.—Germination tests of 8 varieties at the South Carolina Station (*R. 1888, p. 58*) gave an average of 87.7 per cent of good seeds. One thousand seeds weighed 262.9 grams, being about 1,700 seeds to the pound. Similar tests at the Tennessee Station (*B. 2*) of samples from sixteen counties in that State showed a high average vitality of the seed, most of which had been kept dry under shelter in well-ventilated places. There was little difference between ears stored with and without the husk. At the Indiana Station (*B. 6*) ears picked early (before frost) and dried carefully were excellent for seed. In some experiments kiln-dried seed has produced vigorous plants (*N. Y. State B. 8, n. ser., R. 1886, p. 43*). In a test of seed from Southern, Central, and Northern States the Maryland Station (*R. 1890, p. 94*) obtained the best results from seed produced in Kentucky, Kansas, and Maryland, *i. e.*, in the latitude of the station. At the Pennsylvania Station (*B. 8*) tests in the germinating apparatus gave uniformly higher results than those in the field, but the relative variations between different varieties were the same in both cases. At the New York State Station (*B. 111*) seed corn germinated after a long period at as low a temperature as 43.7° F., and the indications were that moisture (inducing mold) rather than low temperature destroyed the seed in the soil.

A number of experiments with kernels from the butt, middle, and tip of the ear have been made with varying results, but on the whole indicate that there is little difference between the seeds from different parts of the ear. At the Ohio Station the average yields per acre for four years were—butt 66.9, middle 62.8, tip 64.8 bush-

els. (*Kans. B. 30; N. Y. State B. 31, B. 47, R. 1882, p. 40, R. 1883, p. 130, R. 1884, p. 90, R. 1885, p. 38; Ohio B. vol. IV, 1, R. 1886, p. 126.*)

RATE OF PLANTING.—The experiments thus far made have indicated that where corn is grown for the grain thicker planting is desirable in the Northern than in the Southern States. At the stations in Georgia, Louisiana, and South Carolina rows 5 feet apart, with stalks at intervals of 3 to 4 feet, were preferred, while at the other stations making such tests rows 3 to 3.5 feet apart, with kernels at intervals of 12 to 16 inches, gave the best average results. Closer planting may in some cases give a heavier weight of green material, but at the expense of grain and dry fodder. Since it has been found that the feeding value of silage is materially increased by ensiling the ears with the stover, enough space should be allowed for their proper development.

In experiments at the Connecticut State Station (*R. 1889, p. 9*), where the rows were 4 feet apart, a flint variety produced the most dry matter when the plants stood 1 foot apart in the row, and a dent variety when the plants stood two to a foot in the row. The yield of sound kernels of dry shelled corn was highest with two plants to the foot. The dry weight of leaves increased regularly with the thickness of planting. The proportion of leaves to total crop was largest when the proportion of sound kernels was smallest. The largest quantities of each food ingredient in the flint maize were obtained where the stalks stood one to a foot. In the case of the dent variety, tested two years, the albuminoids, fat, and nitrogen-free extract were largest one year with stalks two to a foot and the other year with stalks one to a foot. The individual plants which stood farthest apart (4 by 4 feet) attained the greatest development in all their parts. The yield per plant decreased quite regularly as the stand became thicker, but not in the same proportion.

In experiments at the Illinois Station (*B. 20*) on fertile prairie loam with rows $3\frac{2}{3}$ feet apart a medium-sized dent variety gave the largest yields of good corn when planted at the rate of one kernel each 9 to 12 inches; the yield of corn and stover increased with thickness of planting up to one kernel each 3 inches. The food value of the total crop was greatest when the stalks were about 6 inches apart in the row.

(*Conn. State R. 1889, p. 9; Ga. B. 10; Ill. B. 4, B. 8, B. 13, B. 20; Ind. B. 6, B. 14, B. 23, B. 39; Kans. B. 30, R. 1889, p. 6; La. B. 22, B. 7, 2d ser.; Mo. B. 14, B. 22; N. Y. State R. 1882, p. 38, R. 1883, p. 135, R. 1884, p. 101, R. 1886, p. 46, R. 1889, p. 81; N. Y. Cornell B. 4, B. 16; Ohio B. vol. III, 3, B. vol. IV, 1, R. 1882, p. 43, R. 1883, p. 65, R. 1884, p. 73, R. 1885, p. 38, R. 1886, p. 121, R. 1887, p. 154, R. 1888, p. 83; Pa. B. 7, R. 1888, p. 26; S. C. R. 1888, p. 200, R. 1889, p. 210; S. Dak. B. 24; Vt. R. 1888, p. 89, R. 1889, p. 191; Wis. B. 19, R. 1889, p. 126.*)

TIME OF PLANTING.—This will of course depend on local conditions of soil and climate. At the Illinois Station (*B. 4, B. 8, B. 13, B. 20*) the best results during four years were from planting May 11 to 16. In 1891, however, there was little difference in yields from planting at weekly intervals from April 25 to May 23, while later plantings gave much smaller yields. At the Indiana Station (*B. 23, B. 39*) during three years the largest average yields were from planting May 1 rather than later. At the Ohio Station (*R. 1886, p. 117*) early planting was found advantageous in dry seasons.

METHOD OF PLANTING.—Experiments at several stations have indicated that it makes little difference whether corn is planted in hills or in drills (*Ill. B. 20; Kans. R. 1888, p. 32; S. C. R. 1889, p. 252*). The Connecticut State Station (*R. 1890, p. 183*) reports an experiment in which corn was planted in drills (4 feet by 10 inches) and in hills (4 feet by 40 inches with 4 stalks to 20 inches with 2 stalks). That planted in drills gave about 6 per cent larger yield of dry matter and a larger yield of each food ingredient. The composition of the corn and therefore its feeding value was practically the same whether planted in hills or drills. The Kansas Station (*R. 1888, p. 15*) calls attention to the fact that irregularities in planting with the drill may

materially affect the crop. In some sections the seed is drilled in the bottom of deep furrows struck at the usual intervals in ground not otherwise plowed. This practice, called "listing," is favored by experiments at the Kansas Station (*R. 1888, p. 32, R. 1889, p. 6*). At the Minnesota Station (*B. 5*) in 1888 results unfavorable to listing were obtained. The practice of sowing corn broadcast for fodder or silage is condemned by trials at several stations (*Miss. R. 1888, p. 30; N. Y. State R. 1890, p. 260; N. Y. Cornell B. 4*).

PLOWING AND CULTIVATION.—Experiments at the Illinois and Indiana stations during several years indicated that depth of plowing had little influence on the crop. A moderate amount of shallow cultivation is favored by results obtained in numerous experiments. The essential thing in the cultivation of corn is to keep the ground free from weeds and moderately porous.

(*Ark. R. 1888, p. 7; Colo. R. 1890, p. 14; Ga. B. 10, B. 15; Ill. B. 13, B. 20; Ind. B. 6, B. 14, B. 23, B. 39; Iowa B. 16; Kans. B. 30, R. 1888, p. 37, R. 1889, p. 6; La. B. 6; Md. B. 3; Minn. B. 5; Mo. B. 14; N. Y. State R. 1883, p. 132, R. 1884, p. 99, R. 1886, p. 50, R. 1888, p. 173; Ohio B. vol. IV, 1, R. 1883, p. 79, R. 1884, p. 75, R. 1885, p. 42, R. 1886, p. 127, R. 1887, p. 161; S. C. R. 1889, p. 256; S. Dak. B. 9, B. 24.*)

ROOT-PRUNING.—The reason why deep cultivation is likely to prove injurious to the corn crop is brought out by experiments in root-pruning taken in connection with the observations on the root system of the corn plant referred to above.

At the Illinois Station (*B. 8, B. 13*) the following results were reported: "Pruning the roots of corn to the depth of 4 inches, 6 inches from the stalk, has reduced the yield 16 and 23 per cent in 1889 and 1890, respectively. The reason that root-pruning reduced the yield to a greater extent than deep cultivation is probably that the root-pruning was done on all four sides of the hill at each pruning. The depth at 6 inches from the plant has been determined with 251 roots, and 174 were found to be 4 inches or less from the surface and 108, 3 inches or less from the surface. In other words, a cultivator running 4 inches deep would disturb about 70 per cent of the roots, and at 3 inches about 43 per cent. Of 115 roots on four plants examined June 21 and 28, the end or the point where broken of 54 was 12 or more inches deep; of 33, 18 or more inches deep; and of 17, 24 inches deep."

At the Minnesota Station (*B. 5*) in one experiment a knife was run around each hill at a depth of 6 inches and 6 inches from the stalks. The root-pruned plats averaged nearly 3 bushels of corn and 800 pounds of fodder per acre less than the plats not root-pruned. In another experiment (*Minn. B. 11*) root-pruning from one to four times reduced the yield of corn 13½ bushels and of fodder ¼ ton per acre. At the New York State Station (*R. 1888, p. 173*) root-pruning June 9 and 25 at a depth of 3 inches and 4 to 8 inches from the stalks reduced the yield of corn 9 bushels and of fodder 1,020 pounds per acre. See also *N. Y. State R. 1882, p. 38, R. 1883, p. 134; Ohio R. 1884, p. 75.*

STRIPPING, TOPPING, AND DETASSELING.—Stripping off the leaves for fodder during the growth of the crop will reduce the yield of corn, and it is doubtful whether the fodder thus obtained will pay for the labor of gathering it (*Ala. Canebrake B. 10; Fla. B. 16; Ga. B. 10, B. 15; Kans. R. 1888, p. 27; La. B. 22; Miss. R. 1890, p. 26; Tex. B. 19*). Cutting off the tops above the ears when in good condition for fodder in some cases has not decreased the yield of corn (*Ala. Canebrake B. 10; Ill. B. 20; Tex. B. 19*), but in other cases it has (*Kans. R. 1888, p. 27; Miss. R. 1890, p. 20; Nebr. B. 19*). Removing the tassels from a portion of the stalks has sometimes reduced the yield (*Kans. R. 1888, p. 27; Md. R. 1891, p. 358; Nebr. B. 19*), sometimes increased it (*Del. B. 14; Kans. B. 30; N. Y. Cornell B. 25*), and sometimes has produced no definite effect (*Ill. B. 20; N. Y. Cornell B. 40*).

TIME OF CUTTING.—Numerous experiments have shown that the dry matter in the corn plant increases greatly as maturity approaches and that, therefore, whether the crop is grown for grain, fodder, or silage, much will be lost by too early cutting. At the Kansas Station (*B. 30*) corn cut in the milk stage (Aug. 20) yielded 35.5 bush-

els of grain and 2.4 tons of fodder per acre; in dough (Aug. 28), 51 bushels of grain and 2.4 tons of fodder; when ripe (Sept. 18) 74 bushels of grain and 2.7 tons of fodder. These results agreed with those of previous experiments (*Kans. R. 1888, p. 42, R. 1889, p. 6*). At the Minnesota Station (*B. 7*), where corn grown for silage was cut from September 4 to 24, the dry matter in a dent variety (Rustler) increased from 11.4 to 19.7 per cent, and in a sweet variety (Egyptian) from 9.1 to 13.3. At the New York State Station the dry matter per acre in Burrill and Whitman corn cut for silage September 11 was 5,004 pounds, and September 29, 5,660 pounds. In 1889, when the experiment was repeated with King Philip corn. there was an increase in the total amount of dry matter and in the nutritive value of its constituents as the crop approached maturity (*N. Y. State R. 1889, p. 88*). At the New York Cornell Station (*B. 16*) similar results were obtained with Pride of the North corn. These results are confirmed by those at the New Hampshire Station (*B. 3*) with 4 varieties and at the Pennsylvania Station *B. 7, B. 11, R. 1888, p. 26*) with 4 flint and 10 dent varieties. The Wisconsin Station (*B. 19, R. 1889, p. 126*) recommends the cutting of flint varieties for silage when just past glazing, and dent varieties when "well dented." (*Mich. B. 68; Mo. College B. 22; Ohio B., vol. III, 3, B. vol. IV, 1, R. 1888, p. 68; Vt. R. 1889, p. 91.*)

MANURING.—Experience has shown in general that on the more fertile soils of the Central and Western States the use of commercial fertilizers on corn is not profitable at present. Barnyard manure as a rule increases the yield and its effects continue from year to year, but even this may not be profitably used on some soils. In the Eastern and Southern States, on the other hand, more or less liberal manuring with barnyard manure or commercial fertilizers, or with combinations of both, is quite generally profitable. Numerous experiments have indicated that on the whole a complete fertilizer containing phosphoric acid combined with smaller amounts of nitrogen and potash is most likely to give good results. There is, however, increasing evidence that definite rules for the use of fertilizers on corn can not be given. Every farmer must study the needs of his own soil and "write his own prescriptions." Green manures, such as clover, peas, and melilotus, should, without doubt, be more extensively used to keep up the supply of nitrogenous vegetable material in the soil. Brief statements regarding the results of experiments at a number of stations are given below.

At the Alabama College Station (*B. 3, (1887) B. 16, n. ser.*) phosphates were especially needed, and their use in connection with cotton seed (preferably crushed) and stable manure or muriate of potash gave good results.

At the Alabama Canebrake Station (*B. 3, B. 7, B. 10, B. 13*) commercial fertilizers did not pay, but green manuring with peas and melilotus was strongly commended.

At the Arkansas Station (*R. 1888, p. 7, R. 1889, p. 26, R. 1890, p. 8*) good results were obtained with cotton-seed meal and acid phosphate.

The Connecticut State Station (*R. 1888, p. 112, R. 1890, p. 183, R. 1891, p. 139*) found that liberal manuring with barnyard manure largely increased the yield and also the albuminoids in the crop, but not the fat and fiber. In the kernels there was a marked increase in the protein and nitrogen-free extract. A complete commercial fertilizer produced similar but less pronounced results.

The Connecticut Storrs Station (*R. 1888, p. 47, R. 1889, p. 87, R. 1890, pp. 57, 107, 112, R. 1891, p. 173*) found that the largest yields but not always the largest profits were from complete fertilizers containing a relatively small amount of nitrogen (24 pounds per acre). The addition of nitrogen to the minerals increased the protein in the crop. Experiments on several farms showed quite various results from different fertilizers as regards both the yield and composition of the crop.

The Florida Station (*B. 7, B. 11*) recommends the use of cotton-seed meal. On a sandy soil copperas (*B. 16*) in a compost was beneficial.

At the Georgia Station (*B. 10, B. 15*) nitrogen was especially needed and its use in a complete fertilizer is advised.

In Illinois (*B. 4, B. 8, B. 13, B. 20*) experiments at the station and elsewhere showed that commercial fertilizers were not profitable on fertile prairie soil. Stable manure increased the yield and was sometimes profitable.

At the Indiana Station (*B. 6, B. 14, B. 23, B. 39*) horse manure applied in 1883 and 1884 increased the yield each year thereafter up to and including 1891. Gas lime and superphosphate applied at the same time with the manure had no special effect on succeeding crops.

At the Iowa Station (*B. 15, B. 16*) barnyard manure (especially liquid) increased the yield.

At the Kansas Station (*B. 30*) plaster and castor-bean pomace applied separately had no effect.

At the Kentucky Station (*B. 17, B. 26, B. 33*) on the limestone soil of the blue-grass region potash was the element chiefly needed. Larger ears were produced when potash was used, but there was no relation apparent between the fertilizers and the shrinkage of corn in curing or the proportion of kernel to cob.

At the Louisiana State Station (*B. 21, B. 26, B. 7, n. ser., B. 17, n. ser.*) phosphoric acid seemed to be especially needed.

At the North Louisiana Station (*B. 22, B. 27, B. 8, n. ser., B. 16, n. ser.*) nitrogen (combined with phosphoric acid and potash in relatively small quantities) was especially needed (see also *La. B. 2, B. 6*).

At the Massachusetts State Station (*R. 1888, p. 107, R. 1889, p. 148*) the omission of nitrogen from the fertilizer produced light-colored plants and decreased the yield of corn, especially of well-developed ears.

Massachusetts Hatch Station (*B. 14, B. 18*), on the basis of experiments in different localities, advises the use of a complete fertilizer containing a relatively large amount of potash.

The Mississippi Station (*R. 1888, p. 27, R. 1889, p 18, R. 1890, p. 20, R. 1891, p. 8*) has found that a complete fertilizer containing an abundance of vegetable matter is required on exhausted hill lands of yellow and red clay.

At the Missouri Station (*B. 14*) barnyard manure (solid and liquid together) increased the yield. Wood ashes were also effective, but neither salt, lime, nor plaster gave any increase (see also *Mo. College B. 7, B. 30*).

New Hampshire Station (*B. 10*), on the basis of experiments on ten farms, advises the use of a fertilizer containing phosphoric acid (9 to 11 per cent), potash (9 to 15 per cent), and nitrogen (2 to 4 per cent).

In New Jersey (*R. 1888, p. 83, B. 54*) experiments on different farms indicated that potash (especially kainit) was a most profitable fertilizer.

At the New York State Station (*R. 1882, p. 38, R. 1886, p. 47, R. 1888, p. 356*) nitrogen was the element especially needed. In a cool season fertilizers produced relatively little effect (*N. Y. State B. 76; N. Y. Cornell B. 4.*)

In North Carolina (*B. 65, B. 71*) cotton-seed meal alone or in combination with acid phosphate and kainit was relatively satisfactory in different localities.

In Ohio (*B. 7, B. vol. III, 2, B. vol. IV, 1, B. vol. V, 3, R. 1882, p. 46, R. 1883, p. 81, R. 1884, p. 78, R. 1885, p. 44, R. 1886, p. 129, R. 1887, p. 167, R. 1888, p. 68*) fertilizers have not been found profitable. Nitrate of soda with dissolved boneblack or muriate of potash increased the yield in forty-six out of forty-eight trials.

At the Pennsylvania College (*B. 2, B. 8, B. 9, R. 1882, p. 19, R. 1884, p. 22*) phosphoric acid was especially needed.

The Rhode Island Station (*R. 1890, p. 39, R. 1891, p. 35*) on the basis of several experiments advises the use of about 45 pounds of nitrogen, 75 pounds of potash, and 54 pounds of phosphoric acid per acre.

The South Carolina Station (*R. 1888, p. 162, R. 1889, p. 210*) found a complete fertilizer, containing nitrogen and potash in relatively small amounts, most satisfactory.

Texas Station (*R. 1889, p. 11*) during five years' work on poor, shallow upland "post oak" soil with subsoil of stiff clay found cow manure most profitable, though bone meal produced the largest increase in yield. The effect of fertilizers on this soil continued from year to year.

The Vermont Station (*B. 15, R. 1888, p. 89*) found that phosphoric acid was especially needed.

(*Colo. R., 1888, p. 25; Del. B. 11; Me. R. 1889, p. 135, R. 1890, p. 96, R. 1891, p. 45; Md. R. 1889, p. 124, R. 1890, p. 90.*)

Corn-and-cob meal.—The corn and cob are often ground together without shelling, and where the cob is not too large and woody the corn-and-cob meal has given good results in feeding. The ground cob is believed to be of value (1) on account of the food and the ash constituents which it contains, and (2) on account of the beneficial mechanical influence which it has on the digestion of the corn meal. The feeding of corn-and-cob meal depends somewhat on the relative proportion of cob and kernels in the ear, which differ in different varieties. Goessmann found that the proportion of cob in the ear varied from 14 to 18 per cent by weight. For account of feeding trials with corn-and-cob meal see *Gluten meal for milk and butter production; Cattle, feeding for beef and for growth;* and *Pigs, feeding.*

For composition see *Appendix, Tables I and II.*

Corn and soja bean silage.—The Massachusetts State Station made a silage from fodder corn and soja beans mixed half and half, which was much richer in protein and fat than corn silage. The composition of the dry matter was similar to that of red clover hay. The soja bean used was nearly mature and was cut into coarse pieces. See also *Silage.*

Corn, bacterial disease.—The first indication of the presence of this disease is in the dwarfed condition of the young plants. This usually occurs in patches varying from a rod or more square to an acre or more, while the rest of the crop seems unaffected. Later in the season, after the tassels have appeared, it may be found scattered throughout the field, affecting here and there a stalk or hill, while the rest remains free from it. Upon closer examination the stunted plants are seen to be uniformly yellowish, the lower leaves being most affected, and gradually dying. If an affected plant be pulled up, the lowest roots will be found diseased and in bad cases rotted away. The bottom of the stalk will also be affected and the inner tissue of the joints will be discolored. On the surface, when freed from dirt, brown spots more or less spreading may be found with masses of nearly transparent jelly-like substance sometimes adhering to them. After midsummer the disease becomes very apparent on the leaf sheaths, which are marked with spots ranging in size from mere specks up to large patches. These spots are of a brownish color, sometimes a little red, and appear as though half rotten. If the sheaths are stripped from the stalk and examined the whole inside may be found to be spread with the jelly-like mass. Occasionally the ears are attacked. The husks are then marked much as the leaf sheaths are. The whole ear, including husks and silk, becomes soft and wilted. Very often the ears are penetrated by a dense mat of white fungus—a sight well known to all farmers. These are especially abundant in certain seasons most favorable for the development of the bacteria. The bacteria have been isolated and cultures made, demonstrating that they are the cause of this particular disease of corn, but as yet no remedy has been found. (*Ill. B. 6.*)

Corn fodder.—For feeding trials see *Silage.* For composition see *Appendix, Tables I and II.*

Corn meal.—For average composition see *Appendix, Tables I and II.* For accounts of comparisons of corn meal with cotton-seed meal, gluten meal, and linseed meal for milk and butter production see *Cotton-seed meal, Gluten meal,* and *Linseed meal.* For other experiments with corn meal see *Milk, effect of food,* and *Butter-making.*

The effect of substituting 6 pounds of corn meal for 7 pounds of wheat bran the Wisconsin Station (*R. 1886, p. 115*) found to be to diminish the milk yield, and probably the live weight likewise. These amounts of grain were taken as containing nearly the same quantity of digestible food materials. (*N. Y. State R. 1887, p. 15, R. 1889, p. 198; Vt. R. 1890, p. 88.*)

For feeding experiments with corn meal for beef and comparisons with corn-and-cob meal see *Cattle-feeding for beef and for growth.*

Corn salad (*Valerianella* [*Fedia*] *olitoria*).—This plant, also known as fetticus, is used as a salad herb. Seven varieties were tested at the New York State Station (*R. 1884, p. 286, R. 1885, p. 191*). Germination tests of the seed are recorded in *N. Y. State R. 1883, p. 68; Vt. R. 1889, p. 104.*

Corn silage.—See *Silage.*

Corn smut (*Ustilago maydis*).—This disease is found wherever corn is grown, and the well-known black powdery masses on the ear, the tassel or the stalk need no description for their identification. It has been estimated to cause a loss every year of at least 1 per cent of the entire crop in this country, being especially bad in wet lands and during wet seasons. It attacks the corn when quite young, entering the stalk near the ground. It grows with the plant, and after a time appears as white swollen masses on various parts, most commonly on the ears, which soon become black and smutty. It will not spread from plant to plant during the season, but must infect it early in the life of the plant if at all.

It is known that in the presence of moisture the smut can develop into a stage capable of infecting the corn and also continuing its own existence for a very considerable time. This is entirely independent of the corn plant and may take place in the ground or manure heap. This fact being recognized, the importance of destroying all smut patches as soon as found will be readily appreciated. Its spread may be greatly reduced by removing and burning all infested stalks and ears. This should be done wherever corn is followed by corn for several years until the ground becomes thoroughly infested. A change of crop will check it, as this species is confined to corn alone. Another way of spreading the infection may be in the seed itself, and its growth and development will be the same as that of the corn. This may be prevented, it is said, by soaking the grain in a solution of copper sulphate (blue vitrol), 1 pound to a gallon of water, for fifteen or twenty minutes. This will kill all adhering spores. Another and probably better way is to treat the corn in the manner recommended for the treatment of smut of wheat and oats. No application to the plant after it has attained any considerable size will be of any benefit. (*Kans. B. 23; Nebr. B. 11; N. C. B. 76; Ohio B. vol. III, 10*).

Corn stover.—The corn plant after the ears are taken off. For composition see *Appendix, Tables I and II.* In feeding trials, the Vermont Station found (*R. 1889, p. 51*) that corn stover and hay "have about the same feeding value for cows," and "the lower half (butts) of corn stover have as great feeding value per pound of dry matter as the upper half (tips)." The corn furnishing the stover was presumably a Northern variety. See also *Silage.*

For comparison of cut and uncut stover see *Foods, preparation for feeding,* and *Cows, cut vs. uncut stover.*

Cotton (*Gossypium* spp.).—This plant belongs to the order *Malvaceæ,* which also includes okra and the hollyhock. The varieties of cotton cultivated in the Southern States belong to two species, upland cotton (*Gossypium herbaceum*) and sea-island cotton (*Gossypium barbadense*). Cotton was known to the ancient Asiatics and Egyptians, and was found growing wild in America by Columbus and other early explorers. It is therefore thought to be a native of both hemispheres. In its wild state, especially in tropical climates, cotton is a perennial shrub, but as cultivated in the South it is an annual plant. The cultivated cotton plant is a small shrub having alternate stalked and lobed leaves. The flowers of upland cotton are white or cream-colored on the first day, become reddish on the second, and fall on the third,

leaving a small boll enveloped in the calyx. This boll develops until it reaches approximately the size and shape of a hen's egg, when it splits into three to five cells, liberating the numerous black seeds covered with the fibrous wool which constitutes the cotton of commerce. "Formerly cotton was not grown north of the isothermal line 36°, but under the influence of phosphatic manures its cultivation in late years has been extended several degrees beyond this line." It is most successfully cultivated between 30° and 35° north latitude. (For the history and habits of growth of cotton see *La. B. 8* and *B. 13*.) The meteorological conditions of the Southern States, which favor the growth of cotton, are discussed in *S. C. B. 7*. Two periods in the life of this plant may be distinguished. The first extends from the time of planting, which in South Carolina is about the middle of April, to the middle of summer. This is the time in which the plant makes its growth of stalk and foliage and gathers nourishment, which will later be stored up in the seed. During this period tropical conditions are favorable, namely, moisture in the soil from frequent rather than long-continued rain, high temperature with small daily variation, plenty of sunshine, little wind, and a high relative humidity of the atmosphere to reduce evaporation to a minimum. During this period everything possible is done to prevent loss of water from the soil; grass and weeds are scrupulously excluded, and the surface of the soil is frequently stirred to conserve the moisture and increase the temperature of the soil.

In the latter part of the season in South Carolina the temperature rapidly falls and the rainfall diminishes. This is the fruiting period of the cotton crop, when every effort should be made to produce seed rather than stalk and foliage. Every means is taken to dry out the soil; cultivation ceases and the soil is allowed to become hard and compact to favor the evaporation of the moisture. It is believed that differences in moisture and temperature account for the fact that the fine grades of sea-island cotton can be produced only on the islands and in the country immediately adjoining the coast.

VARIETIES.—Numerous varieties of cotton have been tested at the stations in Alabama, Arkansas, Georgia, Louisiana, Mississippi, South Carolina, and Texas. Among the varieties which have given the best results in different localities are the following: Peterkin, Jones Improved, Welborn Pet, Texas Storm and Drouth-Proof, Southern Hope, Peerless, Tennessee, Gold Dust, and Cherry Long Staple. At the Nebraska Station 4 varieties forced in a greenhouse for 36 days and then transplanted to the field did not ripen seed, the season there being about three weeks too short (*Nebr. B. 6*).

Ala. College B. 13, n. ser., contains a report on microscopic examinations of the fiber of 18 varieties of cotton grown on the station farm. The experiments indicate "that it is not always the large plant that produces the best condition of the fiber, and that the most excellent condition of the fiber is produced only on plants which are neither too rapid nor too slow in their development, and which are given all the advantages of judicious cultivation with the proper manuring and under the most favorable conditions of the atmosphere. In improving the grade of cotton the plant must be forced to produce fiber that is (1) long and as nearly as possible uniform in length; (2) of uniform diameter throughout; (3) flat and ribbon-like, and well twisted." Seed selection should be repeated from year to year, and no inferior cotton planted near enough to vitiate the chosen variety with its pollen. In these experiments the strongest fiber was produced by the Truitt variety; the largest by Barnett; the smallest by Hawkins Improved and Peterkin; the longest by Okra Leaf; and the best twisted by Truitt, Rameses, and Cherry Cluster. "The largest percentage of fiber per boll was produced by Welborn Pet, Okra Leaf, Peterkin, Hawkins Improved, and King Improved, in the order named. The best grade of cotton, taking all things into consideration, was Cherry Cluster; the second best grade was Truitt."

The South Carolina Station (*B. 2, n. ser.*) classified the varieties of cotton grown in that State into three groups according to their percentages of lint—long staple, short

staple, and Rio Grande (including Peterkin and Texas Wood). The varieties in the first group produce 31 per cent of lint or less, those in the second 32 to 34 per cent, and those in the third 36 per cent or more. The yield of lint in general increases with the percentage of lint. "It seems to be established that thorough cultivation and careful selection of seed for a number of years will improve the productiveness of any variety or increase its percentage of lint."

(*Ala. College B. 4, B. 5 (1888), n. ser., B. 12, n. ser., B. 16, n. ser., B. 22, n. ser., B. 33, n. ser.; Ala. Canebrake B. 7, B. 11, B. 14; Ark. B. 18, R. 1888, pp. 100, 106, 119, R. 1889, p. 52, R. 1890, p. 147; Ga. B. 11, B. 16; La. B. 21, B. 22, B. 26, B. 27, B. 7, 2d ser., B. 8, 2d ser., R. 1891, p. 4; Miss. B. 18, R. 1890, p. 16, 1891, p. 19; Nebr. B. 6; N. C. R. 1886, p. 74, R. 1887, p. 115; S. C. B. 1 (1888), B. 2, n. ser., R. 1888, p. 218, R. 1889, p. 268; Tex. R. 1889, p. 13.*)

Composition.—A chemical study of the cotton plant was made by J. B. McBryde at the South Carolina Station during 1889 and 1890 and the results were published in *Tenn. B. vol. IV, 5.* The data given include separate analyses of the whole plant, lint, seed, bolls ("the empty burr or capsule after the seed has been removed"), leaves, stem, and roots; of parts of the seeds (kernels and hulls), cotton-seed meal, and cotton-hull ashes; a determination of the relative weight of different parts of the plant; and a comparison of the fertilizing constituents contained in crops of cotton yielding 300 pounds of lint, of corn yielding 20 bushels, and of oats yielding 30 bushels of grain per acre.

Analysis of the whole and parts of the cotton plant.

	Whole plant.		Lint.				Seed.			
			Crop of 1889.		Crop of 1890.		Whole seed.		Water-free kernels.	Water-free hulls.
	Air-dry plant.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.		
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Moisture at 100° C.	7.36	......	6.72	......	6.77	......	7.04	......	......	......
Crude ash	5.81	......	1.50	......	1.80	......	3.29	......	......	......
Nitrogen	1.46	......	0.28	......	0.20	......	3.07	......	5.31	0.39
Phosphoric acid	0.43	7.55	0.07	4.41	0.05	2.94	1.02	31.01	1.84	0.10
Potassium oxide	1.32	22.79	0.64	42.47	0.85	47.10	1.17	35.50	1.22	1.45
Sodium oxide	0.11	1.82	0.03	1.76	0.03	1.51	0.02	0.57	......	......
Calcium oxide	1.42	24.38	0.16	10.36	0.15	8.30	0.19	5.68	0.18	0.18
Magnesium oxide	0.52	8.90	0.11	7.41	0.16	8.96	0.50	15.19	0.88	0.39
Sulphuric acid	0.20	3.43	0.09	5.71	0.09	5.01	0.13	3.90	0.13	0.11
Insoluble matter	0.43	7.46	0.02	1.56	0.03	1.56	0.02	0.69	0.58	0.04

	Bolls.				Leaves.			
	Crop of 1889.		Crop of 1890.		Crop of 1889.		Crop of 1890.	
	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.
	Pr. ct.	*Per ct.*	*Pr. ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Moisture at 100° C.	9.47	....	14.36	....	9.50	....	8.41	....
Crude ash	7.65	....	7.03	....	16.42	....	3.93	....
Nitrogen	1.36	....	0.87	....	2.37	....	0.83	....
Phosphoric acid	0.40	5.25	0.17	2.43	0.46	2.78	0.20	3.50
Potassium oxide	2.91	37.93	3.23	45.90	0.83	5.04	0.92	11.01
Sodium oxide	0.05	0.59	0.05	0.64	0.37	2.22	0.11	1.71
Calcium oxide	1.09	14.28	0.78	11.03	7.08	43.13	1.06	33.99
Magnesium oxide	0.29	3.81	0.21	2.97	1.26	7.68	0.43	6.32
Sulphuric acid	0.56	7.30	0.32	4.48	0.84	5.13	0.14	3.12
Insoluble matter	0.27	3.52	0.31	4.34	0.93	5.65	0.07	10.04

Analysis of the whole and parts of the cotton plant—Continued.

	Stem.				Roots.			
	Crop of 1889.		Crop of 1890.		Crop of 1889.		Crop of 1890.	
	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.	Air-dry.	Ash.
	Pr. ct.	*Per ct.*	*Pr. ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Moisture at 100° C	12.14	....	11.71	....	7.65	....	6.93	....
Crude ash	12.05	....	4.23	....	3.31	....	3.36	....
Nitrogen	2.45	....	0.74	....	0.70	....	0.59	....
Phosphoric acid	0.42	5.01	0.17	4.10	0.17	5.10	0.14	4.02
Potassium oxide	1.33	23.32	1.45	34.35	0.86	26.00	1.34	39.94
Sodium oxide	0.21	2.69	0.09	2.14	0.16	4.88	0.13	3.97
Calcium oxide	4.10	26.87	0.62	14.72	0.70	21.04	0.39	11.49
Magnesium oxide	0.76	10.98	0.30	7.10	0.34	10.16	0.30	8.97
Sulphuric acid	0.38	3.57	0.08	1.95	0.13	3.82	0.10	2.97
Insoluble matter	1.20	1.76	0.17	4.11	0.21	6.19	0.23	6.92

Relative weight of parts of the cotton plant.

	In water-free plant.		
	Weight in ounces.	Weight in grams.	Per cent.
Lint	0.615	17.45	10.56
Seed	1.343	38.07	23.03
Bolls	0.829	23.49	14.21
Leaves	1.181	33.48	20.25
Stems	1.350	38.26	23.15
Roots	0.513	14.55	8.80
Total	5.831	165.30	100.00

Fertilizing constituents contained in a crop of cotton yielding 300 pounds of lint per acre.

	Amount per acre.						
	In 300 pounds lint.	In 654 pounds seed.	In 404 pounds bolls.	In 575 pounds leaves.	In 658 pounds stems.	In 250 pounds roots.	In 2,841 pounds total crop.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Nitrogen	0.72	20.08	4.50	13.85	5.17	1.62	45.94
Phosphoric acid	0.18	6.66	1.14	2.57	1.22	0.38	12.15
Potassium oxide	2.22	7.63	12.20	6.57	7.74	2.75	39.11

Food ingredients in the cotton plant and its parts.

	Lint.	Seed.	Bolls.	Leaves.	Stems.	Roots.	Whole plant.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture at 100° C	6.74	7.04	11.92	10.82	10.06	7.29	7.36
Dry matter	93.26	92.96	88.08	89.18	89.94	92.71	92.64
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of dry matter:							
Crude ash	1.77	3.53	8.33	15.93	4.54	3.60	6.27
Crude cellulose	89.75	24.13	36.90	11.26	50.18	52.39	33.40
Crude fat	0.65	23.26	1.57	7.31	0.90	2.35	4.23
Crude protein	1.61	20.61	7.84	16.89	5.45	4.39	9.85
Nitrogen-free extract	6.22	28.47	45.36	48.61	38.93	37.27	46.25
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Analysis of parts of cotton seed.

	Hand-separated seed.		Machine-hulled seed.	
	Kernels.	Hulls.	Meal.	Hulls.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture at 100° C	6.27	9.16	7.47	11.30
Dry matter	93.73	90.84	92.53	88.70
	100.00	100.00	100.00	100.00
Analysis of dry matter:				
Crude ash	4.30	2.51	7.60	3.30
Crude cellulose	4.67	51.87	4.90	43.85
Crude fat	39.00	0.64	10.01	2.35
Crude protein	31.21	2.41	51.12	5.19
Nitrogen-free extract	20.82	42.57	26.37	45.31
	100.00	100.00	100.00	100.00

CULTURE.—The general results of experience in the culture of cotton are stated by the Louisiana Stations (*B. 8*) as follows:

"The soil best adapted to cotton is not yet fully decided. Clay loams well drained and sandy loams resting upon clay subsoils are both highly recommended. Both should contain a fair amount of vegetable matter.

"The width of the rows and the distance apart of the stalks in the row must depend upon the fertility of the soil and the rain supply. In poor lands or on soils subject to drought during fruiting season, thin planting must be practiced to obtain the largest results. Mr. David Dickson, the great cotton planter of Georgia, always contended that cotton needed distance only one way. If therefore the rows were wide, it could be crowded in the drill and *vice versa.*

"Deep and thorough preparation of soil, followed by pulverization should always precede planting. The planting should be done by some of the excellent and cheap cotton planters now to be everywhere found, since only the machine will give that uniform and straight stand which so facilitates the subsequent chopping. It furthermore economizes the seed, a point of great importance, when the true value of this article as a manure and feeding stuff is appreciated. The first plowing of cotton may be as deep and thorough as possible, but all subsequent workings ought to be as shallow as the character of the land will permit, since root-breaking to this plant is almost a disaster. The implements in general use for the cultivation of cotton are the scooter and scrape, the solid and buzzard-wing sweeps, the side harrows and the numerous cultivators. After every heavy rain the soil should be stirred and during drought a shallow implement run just deep enough to break the continuity of the pores of the soil and to form an upper layer, which shall act as a mulch to conserve the moisture in the soil, has often been found highly beneficial. Grass is an enemy of the cotton planter and should never be permitted (if prevention is possible) to obtain possession of his fields. In cotton as in all other crops the hoe should be used as little as possible. It is an element of cost excessive to bear and with this plant often causes the disease known as "*sore shin*" by breaking or removing the epidermis of the tender stalk in the effort of the hoeman to remove the last spire of grass.

"When to plant, must be decided by the climate and by the character of the soil. When the ground is warm enough to promptly germinate the seed and give a vigorous healthy plant, then the seed can be wisely trusted in the earth. This is usually the case in this latitude in April. Planting in May is often hazardous, on account of the delay in germination, due to the prevalence of drought at this period. When May planting is practiced, the seed should be covered rather deeply and firmed with a light roller."

The advantages of tile drainage are shown by the results of experiments on "black slough bottom" land at the Alabama Canebrake Station (*B. 4, B. 14*).

After a three years' test of drilling as compared with checking, the South Carolina Station (*B. 2, n. ser., R. 1889, p. 324*) reports no great difference of results from the two methods. Checking, however, saves hand labor and gives the farmer more command over his crop. It is somewhat cheaper than drilling.

A number of the stations have made experiments in planting cotton at different distances. In general the results favor rows 4 feet apart, with plants from 2 to 3 feet apart in the row. In *Ga. B. 16* the following statements on this subject were made from experience as confirmed by an experiment at the station:

"(1) On land capable of making between 1 and 1.5 bales of cotton per acre the plants should not be closer than 4 by 2 feet, nor wider probably than 4 by 3 feet.

"(2) The greater the distance given the more important it is to secure an early stand, thin out early, and give rapid cultivation.

"(3) Close planting gives a larger yield in the early fall, or at the first and second pickings. (The 4 by 1 series in the experiment was 161 pounds ahead of the 4 by 2 series at the close of the fourth picking, October 16.) This is because each plant, when planted close, will make nearly it not quite as many blooms in the first few weeks of blooming as each plant in widely planted rows. Between the date of the first and second pickings, a period of 12 days, 1 pound of cotton was yielded by every 15 plants of the 4 by 1 series, while in the 4 by 2 series 12 plants were required to 1 pound. When it is considered that there were only 5,005 plants to the acre in the 4 by 2 series against 9,250 plants in the 4 by 1 series, the explanation of the greater yield of the 4 by 1 series at the second picking is plain. At the fifth picking, November 4, 43 plants in the 4 by 1 series yielded 1 pound, while in the 4 by 2 series 13 plants only yielded 1 pound."

(*Ala. College B. 3 (1888), B. 16, n. ser., B. 22, n. ser., B. 33; n. ser.; Ala. Canebrake B. 4; Ark. B. 18; La. B. 22, B. 27, B. 8, 2d ser.*)

Shallow cultivation has, with an occasional exception, given better results than deep cultivation. The reason for this is found in the root system of the cotton plant, which is naturally small, the individual roots being small and delicate. At the South Carolina Station the roots of eight plants which had grown on light sandy soil with sandy subsoil were examined after the first picking of cotton. The taproots extended "straight down below 2 or 3 feet." The lateral roots commenced about 3 inches below the surface and for the most part did not go below 9 inches. Out of more than twenty plants grown on heavier loam soil, with compact subsoil, only one was found with a well-developed taproot below 9 inches. Most of the lateral roots commenced and were contained within 3 to 9 inches of the surface (*S. C. B. 7, R. 1889, p. 84*). The danger of great injury to plants having such roots from deep cultivation is obvious. In the early part of the season, however, deep cultivation may be beneficial in keeping down grass which is often troublesome after spring rains. (*Ark. R. 1888, p. 117.*)

(*Ala. College B. 3 (1888); Ark. R. 1889, p. 54; Ga. B. 11, B. 16; Miss. R. 1889, p. 13, R. 1890, p. 16.*)

Experiments in cutting off the tops of cotton plants during growth have as a rule indicated that this practice decreased the yield, especially when the topping was done early in the season. (*Ala. College B. 4 (1888); Ala. Canebrake B. 4; Ga. B. 11, B. 16; La. B. 27; Miss. R. 1889, p. 13; S. C. B. 2, n. ser., R. 1889, p. 332.*)

FERTILIZER TESTS.—Experiments have been made at several stations with reference to the kinds and amounts of fertilizers to be used for cotton and the methods and times of their application. As in the case of other crops, the results have varied with the soil and climatic conditions. The conclusions drawn from some of the experiments which have been longest continued are given below.

The South Carolina Station (*B. 2, n. ser., R. 1889, p. 276*) conducted experiments at Darlington and at Spartanburg for three years on lands which were greatly worn

by years of wasteful tillage. At Darlington the soil was sandy, at Spartanburg a mixture of sand and clay. In both soils there was a deficiency of potash and phosphoric acid. Among the general results of the experiments were the following: A combination of phosphoric acid, nitrogen, and potash makes the most effective fertilizer for cotton. Phosphoric acid is the most important element, and nitrogen is more important than potash. The required proportion of the different ingredients is 1 part of nitrogen, $2\frac{1}{4}$ of phosphoric acid, and $\frac{3}{4}$ of potash. The amounts called for by a crop yielding 300 pounds of lint per acre are, nitrogen 20 pounds, phosphoric acid 50 pounds, potash 15 pounds. Beyond a certain limit, which varies with the physical and chemical condition of the soil, an increase in the amount of fertilizer used will not be followed by an increase in the yield of cotton. In choosing between muriate of potash, kainit, and sulphate of potash cost is the only factor which need be considered. Phosphoric acid is of value to cotton in proportion to its solubility. It makes little difference whether nitrogen is used in an organic or inorganic form. Stable manure containing organic nitrogen is the best fertilizer of its class and is lasting or cumulative in its effects. Cotton-seed meal is somewhat better than cotton seed. Nitrate of soda should generally be applied along with the other fertilizers at the time of planting. The lime of marl used alone or in combination with other fertilizers is of no direct value to cotton. Mixed with acid phosphate it may even act injuriously by retarding or preventing its solution in the soil. Applied on leguminous crops, such as cowpeas or vetch, which are to be turned under as a preparation for cotton, its indirect value is great. Copperas has no effect on cotton. Fertilizers may be indifferently drilled or applied broadcast where they are liberally used, but drilling is to be preferred where small amounts are employed.

The following formulas for fertilizers per acre are based on the results above stated:

(1)	Muriate of potash	pounds	30
	Acid phosphate	do	312
	Nitrate of soda	do	125
(2)	Muriate of potash	do	30
	Acid phosphate	do	334
	Dried blood	do	167
(3)	Muriate of potash	do	20
	Acid phosphate	do	281
	Cotton-seed meal	do	286
(4)	Muriate of potash	do	10
	Acid phosphate (with potash), pounds		312
	Cotton-seed meal	pounds	286
(5)	Cotton-seed hull (ashes)	do	45
	Acid phosphate	do	261
	Cotton meal	do	286
(6)	Kainit	do	58
	Acid phosphate	do	300
	Nitrate of soda	do	70
	Stable manure	ton	1
(7)	Wood ashes (unleached)	pounds	164
	Acid phosphate	pounds	261
	Cotton-seed meal	do	286
(8)	Muriate of potash	pounds	20
	Acid phosphate	do	300
	Nitrate of soda	do	64
	Cotton seed	bushels	$23\frac{1}{8}$
(9)	Kainit	pounds	64
	Acid phosphate	do	273
	Cotton-seed meal	do	143
	Cotton seed	bushels	$13\frac{1}{8}$
(10)	Kainit	pounds	45
	Acid phosphate	do	264
	Cotton seed	bushels	$26\frac{3}{8}$
(11)	Acid phosphate	pounds	266
	Nitrate of soda	do	13
	Stable manure	tons	2
(12)	Ammoniated acid phosphate with potash (nitrogen 4 per cent, phosphoric acid 10 per cent, potash 3 per cent), pounds		500

Experiments carried on in different localities in North Carolina have indicated that on the average a combination of 200 pounds acid phosphate, 100 pounds cotton-

seed meal, and 50 pounds kainit will give good results (*N. C. R. 1881, p. 125, R. 1882, p. 70, R. 1885, p. 60, R. 1887, p. 68, R. 1888, p. 80*).

The Louisiana Station (*B. 8 (1887), B. 21*) recommends a compost of 700 pounds of cotton seed meal, 1,100 pounds of acid phosphate, and 200 pounds of kainit. From 200 to 500 pounds of this mixture is to be used per acre. Where cotton seed and stable manure are available a useful compost may be made with 100 bushels of cotton seed, 100 bushels of manure, and 1 ton of acid phosphate. For sandy land 1,000 pounds of kainit may be advantageously added. From 300 to 1,000 pounds of this compost should be applied per acre.

The Mississippi Station (*R. 1889, p. 12, R. 1890, p. 7, R. 1891, p. 10*) states that for the yellow clay soils of the hill region of that State the fertilizer for cotton should contain a liberal supply of potash and organic matter, with smaller amounts of phosphoric acid and nitrogen.

On the "black slough" land of the Canebrake region of Alabama commercial fertilizers were found to be unprofitable (*Ala. Canebrake B. 11*).

Comparisons of the effects of applying the fertilizer all at once before planting and in fractions during the seasons of growth have given conflicting results. For accounts of experiments in this line see *Ala. College B. 4 (1888), B. 22, n. ser., B. 33, n. ser., Ala. Canebrake B. 4; Ga. B. 10, B. 11; La. B. 27.*

(*Ark. B. 1, R. 1888, pp. 8, 101, R. 1889, p. 46; Fla. B. 8, B. 12; La. B. 2 (1886), B. 26, B. 27; B. 7, 2d ser., B. 8, 2d ser., N. C. R. 1881, p. 125, R. 1882, p. 70, R. 1885, p. 60, R. 1887, p. 68, R. 1888, p. 81; Tenn. B. vol. IV, 5.*)

Cotton caterpillar (*Aletia xylina* [*argillacea*]).—The moth of this species is 1 to 1½ inches across the wings and of a light brown color. The fore wings have a dark spot near the center and three very small white spots near the front edge. There are also several wavy lines crossing the wings. It flies at night and as a moth does no harm. It lays its eggs upon the under side of the leaves of cotton. These hatch in two or three days and as each female lays 150 to 200 eggs they increase rapidly. In about twenty days the worm attains full size and rolls itself up in a leaf; there it remains for about ten days, when it reappers as a moth to lay eggs for another brood. Thus there may be from three to six broods in a season. The adult moth will not live through the winter unless it goes far enough south to escape freezing weather.

London purple and Paris green, either dry or in water, are used against the caterpillars with good effect. A kerosene extract of pyrethrum has been tried with good results in Arkansas and has not the evil effect sometimes experienced with the arsenites. (*Ark. B. 12, B. 15, R. 1890, p. 62; Fla. B. 9; Ga. B. 6; N. C. B. 78; S. C. R. 1888, p. 27; Tenn. Special B. E.*)

Cotton-hull ashes.—See *Ashes.*

Cotton hulls.—Preparatory to pressing the oil from cotton seed, the mills grind the seed and sift out the tough seed coat. Though cotton hulls consist of these tough fragments, chiefly fiber, yet they possess considerable value when fed with cotton-seed meal. Since the hulls cost only from $2.50 to $4 a ton they are largely used near the oil mills as a substitute for hay. Beef from such feed is said to be of excellent quality. Recently they have been fed to cows to some extent. A taste for hulls is readily acquired, and there is no evidence that they have any injurious effect on the health of the animal, even when fed in large quantities. For account of feeding experiments with cotton hulls see *Cattle, feeding for beef and for growth.* For composition see *Appendix, Tables I and II.*

A digestion experiment with steers at the North Carolina Station (*B. 80c*) showed the following rate of digestibility for cotton hulls: Protein 25 per cent, fat 80 per cent, nitrogen-free extract 40 per cent, and cellulose 27 per cent. See also *Tex. B. 15.*

Cotton, leaf blights.—A common fungous disease of cotton is described in *Ala. College B. 36* under the name "yellow leaf blight," for the disease formerly called

rust of cotton. The name "rust" is misleading and confusing, as this is not a disease caused by parasitic fungi, but is now considered to be a physiological disease, due to a lack of nutrition or power of assimilation. Fungi of various kinds are often found but they are present on account of the weakened vitality of the plant. This disease is considered due in a great measure to the impoverished condition of the soil, often brought about by continuous cropping with cotton, or on poorly drained and surface-washed soils. It may be largely prevented by restoring the fertility of the soil and by deep and thorough cultivation. Experiments in several States have shown the value of certain fertilizers, especially kainit, in preventing this disease as well as increasing the quantity of the crop.

Red leaf blight is a name given to a similar disease of cotton often seen upon worn-out, sandy land. Treatment similar to that for the yellow leaf blight is advised. (*Ala. College, B. 36, n. ser.*).

Cotton root rot (*Ozonium auricomum*).—The plant attacked by this disease suddenly wilts and becomes dry in about twenty-four hours. At first plants are affected here and there throughout the field, from which centers the infection spreads, producing the so-called "dead spots" in fields. It appears in June and continues until frost.

If the root of a diseased plant be examined a dense mat of fungus will be found, and in numerous places small protuberances. The filaments of the fungus penetrate the tissues of the cotton root. The spots are reddish at first but soon become brown and the softening and decay of the root is very rapid. Sometimes the plant will send out new roots above the diseased portion and by these is sustained through a period of drought, but the return of rains hastens the rot and death of the plant. The same fungus is said to infest sweet potatoes, causing great loss to growers.

So far only preventive treatment can be recommended. Destroy all the diseased plants, rotate crops, and use good fertilizers. It will not do to follow cotton with sweet potatoes, peas, or grapes, as they are liable to the attacks of the same diseases. Use corn, millet, oats, or similar crops for two or three years. (*Ala. College B. 21 n. ser.; Tex. B. 4, B. 7.*)

Cotton seed and cotton-seed meal.—According to the Tenth U. S. Census Reports, the products from 100 pounds of cotton seed at the oil mills are approximately as follows:

	Pounds.
Cotton-seed meal	37.5
Cotton-seed oil	12.5
Cotton-seed hulls	48.9
Short lint from hulls	1.1
	100

For the relative composition of cotton seed and cotton-seed meal see *Appendix, Tables I and II.* The fertilizing ingredients contained in the two materials are given as follows (*Tenn. B. vol. IV, 5*):

Fertilizing ingredients in cotton seed and cotton-seed meal.

	Cotton seed.	Cotton-seed meal.
	Per cent.	*Per cent.*
Moisture (air dry)	7.04	7.04
Nitrogen	3.07	8.14
Phosphoric acid	1.02	3.25
Potash	1.17	2.32

The high fertilizing value of cotton-seed meal has led to its employment directly as a fertilizer. A more rational practice is to feed the meal to animals and apply the manure to the soil. From 80 to 90 per cent of the fertilizing materials of the meal will be voided by the animal in the manure.

COTTON SEED AND COTTON-SEED MEAL FOR MILK AND BUTTER PRODUCTION.—The Texas Station (*B. 11*) found that as compared with corn-and-cob meal, feeding cotton seed or cotton-seed meal improved the creaming of the milk in deep setting, and several stations have found that it tends to give a firmer, harder butter (see *Butter-making, effect of food on churnability and on quality of butter*). In experiments in two years at the Maine Station (*R. 1885–'86, p. 65, R. 1887, p. 84*) the substitution of cotton-seed meal for an equal quantity of corn meal in each case increased the production of both milk and butter to a profitable extent.

At the Mississippi Station (*B. 11, B. 13, B. 15*) cotton seed at $9 was found more economical than cotton-seed meal at $20, and the latter was cheaper than corn meal at $25 per ton. The same station (*B. 21*) concludes from three years' work that "the milk and butter from cows fed on steamed cotton seed cost less than that from cows fed on raw cotton seed, and but little more than one-half as much as that from cows fed on cotton-seed meal. The butter from steamed cotton seed is superior in quality to that from either raw seed or cotton-seed meal."

Cotton-seed meal was compared with equal quantities of gluten meal and linseed meal, fed singly, at the Massachusetts State Station (*B. 41*). When these were fed with hay the yield of milk was highest on cotton-seed meal in the case of five out of six cows, with no material change in composition of milk, but when fed with corn stover or hay and silage the gluten meal compared well with the cotton-seed meal. Making allowance for the value of the fertilizing ingredients, which is highest in case of the cotton-seed meal, the net cost of the cotton-seed meal ration was the lowest of these grains.

Feeding 6 pounds of cotton-seed meal per head and per day did not seem to affect the health of the animals at the Pennsylvania Station (*B. 17*). This station compared cotton-seed meal with wheat bran, pound for pound, with the result that the milk yield increased about one-fifth and the butter quite materially on cotton-seed meal; the melting point of the butter was higher, but the general quality of the butter was rated considerably lower than that produced on bran.

COTTON SEED AND COTTON-SEED MEAL FOR BEEF PRODUCTION.—(1) *Calves.*—The Mississippi Station (*B. 8*) secured results in fattening calves, which were favorable to cotton-seed products. At the Pennsylvania Station (*B. 17*) three young calves were fed daily 1 pound of cotton-seed meal mixed with hot water, in addition to skim milk. Two died, but the third made a fair gain. A post mortem examination of one of the calves showed inflammation of the lungs and pleuræ. (*N. Y. State R. 1890, p. 8, R. 1891, p. 112; Texas B. 14; Vt. R. 1890, p. 88; Wis. R. 1884, p. 78.*)

(2) *Steers.*—Cotton seed and cotton-seed meal have been compared on steers at several stations. With cotton-seed meal at $20, raw or cooked cotton seed at $7, and hay at $6 per ton, the Texas Station (*B. 6*) found the cost of food per 100 pounds of gain in the case of native steers three to four years old to be, on cotton-seed meal $4.47, on boiled cotton seed $2.85, and on raw cotton seed $2.86. The gains were largest on cotton-seed meal and on boiled cotton seed.

In a trial (*Tex. B. 10*) of feeding silage and hay with boiled cotton seed and with cotton-seed meal, the average daily gain with cotton seed was 1.82 pounds, and with cotton-seed meal 2.54 pounds; and the average cost per 100 pounds of gain was $2.80 with the seed and $3.83 with the meal.

Two comparisons of raw cotton seed and cotton-seed meal on native steers at the Arkansas Station (*R. 1890, p. 134*), feeding each with cotton hulls and pea hay, resulted advantageously to the cotton-seed meal as far as gain was concerned, the animals gaining from ½ to ¾ pound more per day on that food than on cotton seed.

In one case the cost of food per pound of gain was more and in the other less on cotton-seed meal.

As between cotton seed or cotton-seed meal and corn meal, in experiments at the Southern stations, where cotton-seed meal is cheap and corn meal relatively expensive, show that rations consisting largely of corn meal have usually resulted in a more costly gain than those consisting largely of cotton-seed products. "The results of two years' feeding experiments bear strong evidence to the superior feeding qualities of cotton-seed products and silage over corn and hay for cattle" (*Tex. B. 10*).

Experiments extending over a number of years were made at the Pennsylvania Agricultural College (*B. 6, B. 10, B. 12*) to compare corn meal and cotton-seed meal. In the trial in 1881–'82 with corn meal at $30 and cotton-seed meal at $40 per ton, the result "was decidedly in favor of the mixed ration of corn meal and cotton-seed meal." In 1882–'83, with these feeds at $26 and $31.50 per ton, respectively, "there was very little difference in the cost of production with corn meal alone and with the mixture of corn meal and cotton-seed meal." In 1883–'84, with the prices at $27.20 and $30, respectively, the substitution of cotton-seed meal for a part of the corn meal diminished the cost of production and also the quantity of food required for a pound of gain. In 1884–'85, with the prices at $18 and $30, respectively, the results were slightly in favor of the cotton-seed meal ration. As a general rule, in these trials the cotton-seed meal ration gave the largest gain in weight.

At the Maine Station (*R. 1887, p. 89*) the effect was tried of replacing 1½ pounds of corn meal by a like amount of cotton-seed meal or linseed meal, feeding like amounts of hay in both cases. With the corn-meal ration (3½ pounds corn meal) the average gain per day was 0.36 pound and the cost of food per pound of gain 28 cents; and with the richer mixed grain ration the average gain per day was 1.16 pounds and the cost per pound 9 cents. Corn meal was reckoned at $24 and cotton-seed meal at $26 per ton. (*Me. R. 1890, p. 71; Mo. College B. 2; Pa. R. 1886, pp. 177, 205; Tenn. B. vol. II. 3; Tex. B. 6, B. 10; Va. B. 3.*)

Effect of cotton seed and cotton-seed meal on the health of animals.—*Cattle and sheep.*—An investigation of the results secured by farmers in feeding cotton hulls and cotton-seed meal to steers, cows, and sheep was reported in *Tenn. B. vol. II, 3*. No injurious effect on the health of the animals was reported. *Tex. B. 11* states that all heavy feeding of cotton seed and cotton-seed meal must be done in cool weather on account of the health of the animals. The Arkansas Station (*B. 9*) details the methods of those who feed cotton-seed meal and hulls to steers on a large scale. If the bowels become too loose some hay is fed with the cotton-seed meal and hulls.

Miss. B. 13 states that cows at the Mississippi Station ate as much as 12 pounds of cotton seed per day and others ate as much as 10 pounds of cotton-seed meal per day without ill effects on health, but these were chiefly native cows and light milkers. In another trial at the same station (*B. 15*) several lots of cows were again fed on heavy cotton-seed rations. Each animal of one lot had daily 9.5 pounds of cotton-seed meal; others ate daily 10.6 pounds roasted cotton seed; and others 9.5 pounds raw cotton seed. Again there is no mention of injury to the health of the animals.

At the Pennsylvania Station (*B. 17*) milch cows were fed a daily ration of 6 pounds of cotton-seed meal without any ill effects. The same bulletin reports the death of two out of three calves, 1½ to 2 months old, fed 1 pound of cotton-seed meal per head daily with skim milk. The third calf was thrifty and made good growth.

The North Carolina Station (*B. 81*) reports that two steers fed from 3 to 5 pounds of cotton-seed meal with from 15 to 20 pounds of hulls each per day gained well and appeared healthy, but "there appeared indications that the digestion of the animals had been impaired."

Pigs.—The Texas Station (*B. 21*) made an extensive test of the effect of cotton-seed meal and of roasted, boiled, and soaked cotton seed on the health of pigs. Death usually occurred in from six to eight weeks after cotton seed or cotton seed meal was introduced into the ration. All the rations contained a very large per cent

of cotton-seed or meal. The mortality of the pigs fed on cotton seed meal was 87 per cent, on roasted cotton seed 75 per cent, and on boiled cotton seed 25 per cent.

The bulletin also states that in previous years the swine on the farm have died soon after a very small quantity of cotton-seed meal was added to the slop.

At the Virginia Station (*B. 10*) pigs were fed all they would eat of a ration of five parts cotton-seed meal, two parts bran, and two parts beef scraps, giving a nutritive ratio of 1:2.35. All died.

Cottonwood (*Populus monilifera*).—The cottonwood as noted in *S. Dak. B. 23* "has been more used than any other tree in the plantations of the Western prairies. It is hardy, is the most rapid grower of any of the natives, is propagated readily either from seeds or cuttings, and makes firewood more quickly than any species." It reaches its highest development further south, but attains large size in South Dakota under favorable conditions. It is most at home on rich bottom lands, but is also successful on high prairies. Objections are that it is not a dense foliage tree and does not prevent weed growth (its most serious defect); that its wood is of little value; that it is a rank feeder and not a good neighbor for more valuable trees, and that it receives immense damage from the cottonwood leaf beetle. Its one virtue of rapid growth is not thought sufficient to warrant its use in groves. (See also *S. Dak. B. 12, B. 15, B. 20, B. 29.*) In *B. 15* an experiment is reported in using cottonwood as a stock for grafting silver-leafed poplars. Of 100 whip grafts only 2 lived, but of 400 wedge grafts about 40 per cent grew, usually forming a perfect union. In *Minn. B. 24*, while the ordinary tree is not approved except for wind-breaks, a better variety is noted "with yellow heartwood and perhaps larger-leafed, called yellow cottonwood found in the Mississippi Valley," of which the timber "for many purposes will compare with white pine." A variety with golden-green leaves, considered as ornamental, is noted in the same bulletin and named in some station lists.

At the Nebraska Station (*B. 11*) an investigation was made of the question whether the cottonwood has any secondary sexual characters. Observations on a large number of trees indicated that the staminate trees on the whole show leaves earlier, and hold them later than the pistillate, though this is not invariably the case; and that a greater number of lateral buds than terminal are developed in the staminate, while the opposite is true of the pistillate trees. These differences, however, are ascribed to the consumption of energy by the pistillate trees in producing fruit, and hence are considered primary rather than secondary characters; accordingly the main question is answered in the negative.

Cottonwood leaf beetle (*Lina scripta* and *L. lapponica*).—This insect attacks not only the cottonwood, but also the Balm of Gilead, Russian poplar, and willow trees, and in those States where arboriculture is important it is often quite troublesome. The adult is a variously spotted beetle, about one-half inch long. It hibernates under rubbish, to appear on the trees as soon as warm weather comes on. It is advisable to kill the beetles as soon as possible to prevent their laying eggs. The yellow eggs are laid in bunches and hatch in about a week. The young larvæ are nearly black. At first they keep close together on the under side of the leaf, but soon scatter to eat it all but the ribs. In this way the trees may be defoliated. Along their bodies are little tubercles from which they eject small drops of offensive smelling fluid. When full grown the larvæ frequently collect in large numbers near the ground upon the trunk of the tree. Here they undergo their final transformation and become beetles. The whole cycle from egg to insect is passed in about a month. Paris green and London purple, 1 pound to 100 gallons of water, will destroy them. (*Colo. B. 6; Nebr B. 14; S. Dak. B. 22.*)

Couch grass.—See *Weeds.*

Cow cabbage.—See *Kale.*

Cowpea (*Vigna* [*Dolichos*] *katiang var. sinensis*).—A leguminous annual, of uncertain botanical relations, having a luxuriant growth of vines and producing long pods containing edible peas (or beans). Being a native of warm climates it grows

best in our Southern States. When grown in the North it produces a large amount of green forage but will not ripen seed (*Mass. State R. 1888, pp. 51, 118, 222; Minn. B. 11*). A number of varieties, such as Black, Red Tory, Clay, and Unknown are grown (*La. 8, 2d ser. B. 19, 2d ser.*). The cowpea is extensively grown in the Southern States for green forage and hay, but especially as a crop to be plowed under to enrich the soil. Experiments at the Massachusetts State (*B. 36, R. 1884, p. 94, R. 1885, p. 71, R. 1886, p. 79, R. 1887, p. 36, R. 1888, p. 118, R. 1889, p. 190*), and Connecticut Storrs Stations (*B. 6, R. 1888, R. 1890*) have indicated that cowpeas may be a desirable crop for Northern farmers wishing to improve their farms by green manuring and diversification of crops.

COMPOSITION.—The chief value of cowpeas is due to the large amount of nitrogen contained in the plants. A part of this nitrogen is collected from the air (see *Leguminous plants* and *Green manuring*). For analyses of the green vines, hay, and seed see *Appendix, Tables I and II.*

The relative amounts of fertilizing ingredients per acre in cowpeas, oats, and corn as given by the South Carolina Station (*R. 1889, p. 176*) are as follows:

	Cow peas (vines).	Oats (grain and straw).	Corn (kernels and stover).
	Pounds.	*Pounds.*	*Pounds.*
Nitrogen	205.0	35.0	45.0
Phosphoric acid	33.0	12.0	14.0
Potash	155.0	48.0	46.0

(*Ala. College B. 14, n. ser.; Conn. Storrs R. 1890, p. 27; Ga. B. 4, B. 11; Pa. B. 6, R. 1888, p. 44; S. C. B. 8, R. 1888, p. 125.*)

CULTURE.—The North Carolina Station (*B. 73*) makes the following statements from the standpoint of the Southern farmer: "The cowpea, being a tender annual, should always be sown in the spring. It will give a good yield sown as late as July 1, but the earlier it is sown after danger of frost is past the heavier the yield. The pea is usually sown broadcast at the rate of 2 bushels per acre and plowed and harrowed in. The cowpea is not affected by heat and is less sensitive to drought than any of the clovers. If cut when coming into bloom, the roots will sprout and give a second and even a third cutting, if the season is long enough. The yield of air-dry hay is from 2 to 4 tons at each cutting, but greater yields have been obtained. When allowed to mature seed, the yield is 15 to 25 bushels per acre." The difficulty of curing the hay is one objection to this use of cowpeas. The seeds are also troublesome to gather and thresh out.

That cowpeas are not adapted to all localities is evidenced by experiments at the Kansas Station (*R. 1888, p. 63, R. 1889, p. 42*), where the forage obtained from them was of poor quality.

MANURING.—Experiments have shown that cowpeas respond readily to applications of potash and phosphates when the soils used are deficient in these elements (*Ga. B. 3, B. 17; N. C. B. 73*).

MANURIAL VALUE.—Inasmuch as cowpeas are large gatherers of nitrogen, and also secure considerable amounts of potash and phosphoric acid through their extensive root system, which reaches down to the subsoil, they have a high fertilizing value. How to get the greatest benefit from the fertilizing constituents of cowpeas is one of the problems on which the stations are working. If the cowpeas are plowed under in the fall and the ground left bare until spring a large share of the nitrogen they contain will be leached away. By sowing wheat or rye after the cowpeas are plowed under part of this loss may be avoided. If the vines are cut and allowed to lie on the ground during the winter the nitrogen is rapidly lost. In an experiment at the Alabama College Station (*B. 14, n. ser.*) it was found that vines gathered in October had from 1.45 to 2.62 per cent of nitrogen, while if left on the ground

until January they had only about 0.70 per cent, *i. e.*, they lost two-thirds of their most valuable fertilizing ingredients.

If the vines are removed from the soil only a relatively small part of the fertilizing constituents of the plant remains in the roots and stubble. In one experiment (*Ala. College B. 14, n. ser.*) it was found that on the average the air-dried material in the vines weighed six times as much as that in the roots and stubble. If, however, the vines can be fed to stock in the form of hay or silage and the manure returned to the soil, the most economical use will be made of this crop (*Ala. College B. 16, n. ser.; Ala. Canebrake B. 9, B. 10; N. C. B. 73*).

See also *La. B. 8, B. 27; Nebr. B. 6, B. 11.*

Cows.—Under this heading will be treated (1) tests of dairy breeds, (2) effect of grain ration for cows at pasture, (3) cut *vs.* uncut corn stover, (4) mixed rations for cows, (5) warm *vs.* cold water, and (6) miscellaneous work not otherwise mentioned.

For feeding experiments for milk see below and under *Corn meal, Gluten meal, Flaxseed, Linseed meal, Cotton seed and cotton-seed meal, Silage, Soiling.* For feeding experiments with cows for beef, see *Cattle, feeding for beef and for growth.* For milk, see *Milk.* For effect of food on milk, see *Milk, effect of food.* For effect of spaying on milk flow, see *Spaying.*

COWS, TESTS OF DAIRY BREEDS.—Quite extensive tests of dairy breeds of cows have been undertaken by the Maine, New Jersey, and New York State Stations (*Me. R. 1889, p. 106, R. 1890, p. 17; N. J. B. 57, B. 61, B. 65, B. 68, B. 77, R. 1889, p. 178, R. 1890, p. 169; N. Y. State B. 18, B. 21, B. 34, R. 1890, pp. 171, 401, R. 1891, pp. 28, 299*).

At the Maine Station the test included the Jersey, Ayrshire, and Holstein breeds, two registered cows of each breed being used. The test continued for two years. The two Jerseys averaged 629 pounds of butter per year, the two Holsteins 541 pounds, and the two Ayrshires 396 pounds. The Holsteins gave 16,738 pounds of milk per year, the Ayrshires 13,225 pounds, and the Jerseys 10,921 pounds. The Holsteins produced the largest quantity of milk solids per year and there was little difference between the Jerseys and Ayrshires in this respect. Calculating the cost of the milk and butter in the case of the several breeds on the basis of the first cost of the food and making no allowance for the value of manure or of skim milk and buttermilk, the Holstein milk cost the least and the Jersey milk the most per quart or pound, and the butter fat in the Holstein and Ayrshire milk cost on an average from 20 to 30 per cent more than that in the Jersey milk. In other words, the cost of food per pound of butter fat was 16 and 23 cents with the Jerseys, 22.6 and 31.4 cents with the Holsteins, and 31 and 32 cents with the Ayrshires, respectively. The average loss of fat in butter-making (skim and buttermilk) was least with the Jersey milk, and the Jerseys uniformly produced the richest cream.

Concerning the cost of keeping, the food for a Holstein weighing 1,200 pounds cost only $11 per year more than than for a Jersey weighing 900 pounds. "The quantity of food has not been in proportion to the weight of the animals."

The New Jersey Station commenced in May, 1889, a test of Ayrshire, Guernsey, Holstein, Jersey, and Shorthorn breeds, which was prematurely terminated by fire in November, 1890. There were three representative cows of each breed. The data secured show that the Holsteins gave the largest yield of milk, the Ayrshires and Shorthorns the next largest, and the Guernseys and Jerseys the smallest yield. The average cost of food per quart of milk ranged from 1.66 cents with the Ayrshires to 1.91 cents with the Jerseys; and the cost per pound of butter fat was, Guernseys 15.3 cents, Jerseys 17.9 cents, Ayrshires 20.6 cents, Shorthorns 20.8 cents, and Holsteins 22.4 cents. The breeds are divided into three groups on the basis of the cost of food per quart of milk or per pound of butter fat, as follows: (1) Guernseys and Jerseys, (2) Ayrshires and Shorthorns, and (3) Holsteins; but while the first group leads in cheapness of butter production the third group (Holstein) leads in cheapness of milk production. "In the milk class the average cost of a quart of milk is less than in the butter class, and in the butter class the average cost of a pound of

butter is less than in the milk class." The Guernseys were dry for the shortest period; the Ayrshires and Jerseys averaged about a month each, and the Holsteins and Shorthorns about two months a year.

The New York State Station has in progress the most extensive test of breeds of dairy cows undertaken by any station. The test was commenced in April, 1889, and includes six breeds, Holstein, Ayrshire, Jersey, Guernsey, American Holderness, and Devon, with from two to four cows of each breed. The observations thus far published are for one (the first) period of lactation in the case of each cow. The average daily yields of milk and butter during this period were as follows:

Average daily yield of milk and butter.

Breed.	Milk.	Butter.
	Pounds.	*Pound.*
Jersey	14.9	0.89
Guernsey	16.6	0.90
Devon	12.0	0.51
Holstein	24.3	0.79
Holderness	14.9	0.52
Ayrshire	18.6	0.61

The Holsteins gave the largest amount of milk; but the Guernseys, closely followed by the Jerseys, gave the largest average yield of butter per day. "If the milk of the Holsteins did not lose so much fat in creaming [by deep setting] the Holsteins would easily make the largest amount of butter." It is believed this excessive loss of fat may be remedied by using a separator. The fat of the Guernsey milk was recovered most completely in butter-making; that is, there was least loss of fat in skim milk and buttermilk in case of this milk. The average amount of butter made from 1 pound of fat in the milk was Guernseys, 1.07 pounds; Jerseys, 1.04; Holdernesses, 0.98; Devons, 0.97; Ayrshires, 0.93; and Holsteins, 0.88 pounds. The Jersey milk contained more fat per 100 pounds of milk and creamed slightly less perfectly than the Guernsey milk.

The cost of food per quart of milk was lowest in case of the Holsteins, Ayrshires, and Guernseys, in the order named, and highest in case of the Jerseys. The average cost of food per pound of butter during one period of lactation was Guernseys 14.07 cents, Jerseys 16.7 cents, Holdernesses 22.04 cents, Devons 22.17 cents, Holsteins 22.61, and Ayrshires 23.03 cents. The calculated profits per cow from butter-making during ten weeks were largest with the Guernseys and Jerseys and smallest with the Ayrshires and Devons; the Holsteins and Holdernesses were but slightly better than the two latter in this respect.

An estimate is made as to the amount of cheese which the milk of each breed might be expected to yield. This is a calclulation merely based upon experience at the station in making cheese from different kinds of milk. From this estimate it appears that for cheese production the Holsteins stand first, with the Guernseys closely following. The cost of food per pound of cheese was lowest with the Guernseys, Holsteins, and Ayrshires, in the order named.

From the results thus far secured at the New York State Station "it appears that the Guernseys and Jerseys are by far the most profitable for butter production, as compared with the other breeds, while for cheese production the Holsteins stand first with the Jerseys closely following."

For analyses of breed milk see *Milk, properties and composition.*

COWS, EFFECT OF GRAIN RATION WITH PASTURAGE.—For three seasons (1889, 1890, 1891) the New York Cornell Station (*B. 13, B. 22, B. 36*) compared the effects of grain *vs.* no grain for cows on pasturage. The grain consisted of a mixture of cotton-seed

meal and bran fed alone or with malt sprouts or corn meal. The first two years the pasturage was luxuriant and there was no increased yield of either milk or butter from feeding the grain. The yield of butter was practically the same for the lots with and without grain. The first year the milk fell off in yield but became richer in fat on grain. The third year the pasture was at no time very luxuriant. The eight cows receiving grain produced just enough more milk and butter to pay for the cost of the grain. The last two years the changes in live weight were observed and it was found that the cows receiving grain increased more in live weight than those receiving no grain.

The Kansas Station (*R. 1888, p. 69*) observed an increased yield of milk and butter when either corn meal, wheat bran, or ground oats were fed in addition to pasturage, but this increase did not nearly pay the cost of the grain. It should be mentioned that in the above experiments no account is taken of the increased value of the manure or the saving of pastures due to the grain fed.

COWS, CUT VS. UNCUT CORN STOVER AS FOOD.—In a trial of feeding uncut cornstalks to cows, the Wisconsin Station (*R. 1884, p. 11*) found that 34 per cent of the whole weight of the fodder was left uneaten. Three experiments on the value of cut and uncut stover followed (*Wis. R. 1885, p. 9, R. 1886, p. 34*). The first two were with Pride of the North and the third with Stowell Evergreen corn. "In the first trial our uneaten fodder was 14 per cent of the total fed, while the gain by cutting was 36 per cent; in the second trial the uneaten stalks were 30 per cent of the total fed, while the gain was 31 per cent by cutting; and in the third trial the stalks uneaten were 9 per cent, while the gain by cutting was also just 9 per cent. It will be seen that there must be considerable value in the stalks of corn after they are stripped of leaves."

COWS, MIXED RATIONS.—For formulas for mixing rations for dairy cows see *Me. R. 1887, p. 93; N. H. B. 4; N. J. B. 10, R. 1883, p. 73; N. Y. State B. 17; N. C. B. 66.*

COWS, WARM VS. COLD WATER.—Experiments have been made at a number of stations to compare the yield of milk and butter on warm and cold water. The most extensive of these were at the Wisconsin Station (*R. 1889, p. 146, R. 1890, p. 163*), where trials were made for two years, using six cows each year. Ice water was compared with water heated at 70° F. Most of the cows seemed to prefer the warm water. As a rule the cows drank more water, ate more food, and produced slightly more milk on the warm water than on the cold. The increase in milk solids did not correspond with the increase in yield of milk. "The water in the milk was greatest following the days when the most water was drank." As to the effect of the warm and cold water on the weight of the cows, the results in the two years are not concordant. The first year the majority gained in weight on cold water and fell off in weight on warm water, although they ate and drank more on warm water. In the second year no such relation was noticed.

In trials at the Minnesota Station (*R. 1888, p. 119*) there was practically no difference between the amounts of food eaten, of milk and butter produced, and of milk and of food required per pound of butter while on warm water (70°) and on cold (ice) water. With a single exception more warm water than cold water was drank. However, the cows gained more in live weight on cold water than on warm water. The indications were that with good shelter and care cold water was as good as warm water.

In a trial with two cows at New York State Station (*R. 1889, p. 290*) the yield of milk averaged about $1\frac{1}{2}$ pounds more on water heated to 96° F. than on water at 36° F. and the cows drank about 9 pounds more per day of the warm water. Whether or not there were changes in the composition of the milk is not stated.

In a trial with a single cow at Michigan Station (*R. 1888, p. 139*) more milk and slightly more butter were produced on warm water and more water was drank.

See also *Ind. B. 24; Vt. R. 1889, p. 54.*

COWS, MISCELLANEOUS.—Experiments with various feeding stuffs—bone meal (*Vt. R. 1887, p. 81*); light *vs.* heavy meal (*Vt. R. 1890, p. 88*); acid and putrefying food (*N. Y. State B. 106, B. 110, B. 114, R. 1884, p. 49*); timothy *vs.* clover hay (*Me. R. 1887, p. 84*); timothy *vs.* Bermuda hay (*Miss. B. 13, B. 15, R. 1891, p. 26*); glucose or starch waste (*N. Y. R. 1885, p. 10*); malt sprouts (*Wis. R. 1884, p. 78*); brewers' grains (*N. Y. State B. 104*); corn meal *vs.* cotton-seed meal and palm-nut meal (*N. Y. State R. 1890, p. 8*); comparison of silage with grain feed and of corn meal alone or with shorts with gluten meal and bran (*N. Y. State B. 34, B. 35*); comparison of a mixture of bran and buckwheat middlings with a mixture of corn meal, cotton-seed meal, and linseed meal (*Vt. R. 1890, p. 88*); sorghum seed (*N. J. B. 24*).

Experiments with reference to effect of food on milk: (1) On quantity and quality, by heavy feeding of grain (*Vt. R. 1890, p. 75*), by change from barn to pasture (*Vt. R. 1890, p. 107*), by different rations (*N. Y. State R. 1883, p. 156*); (2) on yield, effect of nutritive ratio (*N. H. B. 13; Wis. R. 1886, p. 147*); (3) on composition (*Mass. R. 1884, p. 59*); (4) general (*N. Y. State B. 33, R. 1883, p. 95*).

Observations on a herd of milch cows (*Conn. State R. 1891, p. 96*); rations fed to milch cows by New York dairymen (*N. Y. State B. 17, n. ser.*); salting cows (*Miss. R. 1888, p. 42; N. Y. State R. 1883, p. 116*); how much water does a cow drink? (*N. Y. State R. 1886, p. 24*); amount and value of manure from cow (*N. Y. Cornell B. 27*).

Experiments in feeding cows in general: *Iowa B. 14; Mass. State B. 36; Mich. B. 4; Miss. R. 1889, p. 36; N. H. R. 1888, p. 47; N. Y. State B. 23, R. 1886, p. 28; Wis. R. 1886, p. 99.*

Crab apple.—Tests of varieties are reported in *Ark. R. 1890, p. 35; Colo. R. 1889, p. 117; N. Y. State R. 1883, p. 35, R. 1889, p. 349; R. I. B. 7; S. Dak. B. 26.*

At the Massachusetts Hatch Station (*R. 1888, p. 18*) the experiment was tried of girdling crab-apple trees to increase fruitfulness. Rings of bark were removed on different trees one-eighth, one quarter, and one-half inch wide, close to the ground, just below the main branches, and on one or more of the main branches. The girdles near the ground healed perfectly, those under the main branches sufficiently well for a good growth, those on the branches not so well. A marked increase of fruitfulness resulted, but the effect on the permanent health of the tree could be determined only by observations through many years.

At the same station (*B. 17*) Siberian crab trees were top-budded with apple to test the value of the former as a stock. The buds all grew well the first season, but subsequently very little.

Crab grass.—See *Grasses*.

Cranberry (*Vaccinium oxycoccus*).—The investigation of the cranberry at the stations has related almost entirely to overcoming its insect and fungus pests, and has been confined to the States of Massachusetts and New Jersey. In *Mass. Hatch B. 19* some statistics of the cranberry industry in that State are given. The estimated yields of nine years are given, that for 1891 being 157,000 barrels and its probable value $1,000,000.

Sugar and ash analyses of cranberries and an ash analysis of the vines are given in *Mass. State R. 1889, p. 274, 302, R. 1890, p. 305, R. 1891, p. 337* (see *Appendix, Table III*).

Cranberry gall fungus (*Synchytrium vaccinii*).—This disease, although very local in New Jersey, threatens the extinction of the plant in some places. It produces minute cup-shaped, bright red outgrowths upon leaves, stems, flowers, and fruit, and so robs the plant of its vitality as to render it worthless. It also attacks the azaleas, huckleberry, wintergreen, and similar plants on the edge of the bog, which are reached by the water at high flood. It is thought the disease spreads by the water carrying the infection. If the water supply can be controlled the withholding of water during the winter and spring has been attended with good results. Where such conditions are wanting burning the bog is the only means of relief known. (*N. J. B. 64; R. 1890, p. 332.*)

Cranberry insects.—The New Jersey and Massachusetts Hatch Stations have investigated these insects very thoroughly. There are quite a number of destructive insects preying on the cranberry, the more important of which are the black-headed worm, the yellow-headed worm, the fruit worm, and the tip worm.

The black-headed worm (*Rhopobota vacciniana*) [also called vine worm or fire worm] is the larva of a moth. It does not fly very readily in the daytime, but may be found starting up to light after a short flight. There are two broods each year. The eggs retain their vitality during the winter and hatch early in May. The larvæ eat the leaves, spinning them into a web at the same time. The larva is a small, slender, velvety green caterpillar, with a black head. The second brood appear about the time of blooming and are more destructive than the first. They web more leaves together and bite the leaves just enough to kill them and destroy all the flowers. In two or three days they can change a bog from green to brown.

The yellow-headed worm (*Teras vacciniivorana*) is somewhat like the above in that the larvæ spin webs and are green in color, but they have yellow heads. The moths are orange in summer and slate gray in autumn. The gray ones spend the winter on vines and under rubbish. The eggs are laid early in spring and hatch in May. The caterpillar changes into an orange-colored moth in about a month. There are usually three broods per season, the last being the gray moths, the larvæ of which are reddish in color.

If the water supply can be controlled, drawing off the water early and flooding for two days, just after eggs of the first brood begin hatching, will kill most of them. Holding the water late in the spring is also beneficial. Pyrethrum, dry and in infusion, has been tried with favorable results. White hellebore is good. Tobacco decoction, 1½ pounds to a gallon of water, gives sufficient return to more than pay for itself. Kerosene emulsion as a spray applied to the vines was tried quite effectively, as were also Paris green and London purple (1 pound to 150 gallons of water) sprayed over the plants just after the larvæ were hatched. If they begin webbing use the kerosene emulsion.

The fruit worm (*Acrobasis vacinii*) is the larva of a gray moth. It shades to nearly black and is splotched with white. The eggs are laid on the berry when just forming. They hatch in five or six days and soon eat their way into the fruit, closing the opening with a web of fine silk. After attaining about half their growth they seek another berry and so on until mature. The larva is about half an inch long, green tinged with red, and reaches maturity in September. Spray the vines with Paris green or London purple just after the fall of the flowers.

The tip worm (*Cecidomyia vaccinii*) eats out the terminal bud, causing laterals to come out. It stunts the plant for a short time, but is not generally considered troublesome.

A minute scale insect has been found abundant in some bogs.

Grasshoppers, katydids, and leaf hoppers destroy some plants and berries, but not many. (*Mass. Hatch B. 19; N. J. B. K, R. 1890, p. 487.*)

Cranberry scald.—A fungous disease well known to cranberry-growers, often causing a loss of half the crop. It receives its name from the scalded appearance of the affected berry.

At first a portion of the berry becomes soft, and the skin tense and of a reddish brown color. Sometimes only a portion of the berry decays and the spores of the fungus may be seen in the minute dark specks. A rank growth of fungus filaments is always associated with the scald. The same filaments are to be found in the roots, stems, and leaves of the affected plants, and similar pustules develop on the leaves and fruit. Various fungicides have been tried without obtaining any very satisfactory results. However, it has been learned that covering the bog with a layer an inch deep of fresh earth, clay, or sand will nearly always give relief from the scald. This can best be done when the bog is flooded. This treatment may be too expensive to pay. This disease seems to be due to conditions of the soil and water, and these must be looked after if anything is to be done with the scald. (*N. J. B. 64, R. 1890, p. 334.*)

Cream.—The composition of cream is influenced by the method and conditions of creaming and varies within wide limits. The quality of the cream separated by a centrifugal separator can be changed by regulating the machine. The quality of the cream raised in deep setting depends very materially on the characteristics of the herd and the temperature and duration of the setting. For further particulars see *Creaming of milk* and *Creameries, paying for milk.* For the average composition of cream from American analyses see *Dairy products, composition.* For the ripening of cream see *Churning* and *Butter.*

Cream aërators.—See *Aërators.*

Cream coolers.—See *Aërators.*

Creameries.—For description of creamery buildings see *Dairy buildings.* For description of creamery outfit and apparatus see *Dairy apparatus.*

In general.—Reports on creamery management, suggestions for establishing and maintaining creameries, etc., have been published as follows: *Conn. State B. 108; Del. R. 1889, p. 164; Ill. B. 9, B. 10, B. 14; Iowa B. 8, B. 9, B. 11; Mass. State B. 34, R. 1889, pp. 73, 84; Nev. B. 16; Pa. B. 12; Tex. B. 5; Vt. R. 1888, pp. 142, B. 16, B. 21; W. Va. B. 4, B. 6, B. 13, R. 1890, p. 29; Wis. B. 24, R. 1890, p. 98.*

Paying for milk at creameries.—Until quite recently the common practice at creameries has been to pay the patrons according to the quantity of milk or cream furnished, without any regard to its composition, further than to guard against watering, partial skimming, or adulteration. The stations of this country have done much to call attention to the injustice of this plan of paying for milk arising from the wide differences between the percentages of fat in the milk or cream furnished by different herds. The value of milk for butter-making depends, not upon its volume or weight, but *upon the quantity of fat it contains;* and the quantity of fat in a given quantity of milk is indicated by the percentage of fat in that particular milk.

The following examples illustrate the wide differences in milk supplied by different patrons:

The Illinois Station (*B. 9*) tested the milk brought to three large creameries in the State by one hundred and eighty-four patrons. This milk was found to vary all the way from 2.8 to 4.75 per cent in butter fat. If the milk containing 2.8 per cent of fat is paid for at the rate of 50 cents per 100 pounds, then the richer milk would be worth 84.8 cents per 100 pounds. The Vermont Station tested the milk delivered by twenty-seven patrons to a creamery in that State and found it to vary from 3.35 to 4.91 per cent in fat. This creamery was at the time paying 60 cents per 100 pounds for all the milk it received. Valued according to its quality at this rate, the poorest milk, with 3.35 per cent of fat, would be worth 52 cents, and the richest, with 4.91 per cent, 74 cents per hundred, a difference of 22 cents on every 100 pounds. As 270 pounds of the richer milk were brought in one day, this difference would make a considerable amount in the course of a year to the patron who furnished it.

The Connecticut State Station (*B. 106*) sampled the milk brought to a creamery by two hundred and six patrons. The milk brought by one patron contained 3.28 per cent of fat and that brought by his neighbor 5.25 per cent of fat; that is, 100 pounds of the first milk contained 3.28 pounds of fat, and 100 pounds of the other milk contained 5.25 pounds of fat, but both patrons were paid the same price per 100 pounds for their milk—$1.10. Supposing each patron to bring 1,500 pounds of milk per week, which was paid for on the basis of the fat it contained, the former would receive $14.43 and the latter $20.63 for each week's milk, and both patrons would thus receive alike 27½ cents per pound for the butter fat in their milk.

Prof. Patrick, of the Iowa Station (*B. 9*), denounces the practice as a pooling system. "It makes no pretense to justice in its treatment of the individual patron; it places a premium on quantity rather than, and even at expense of, quality; it drives patrons possessing rich-milk dairy herds and those who feed liberally and intelligently, into private dairying; it tempts the short-sighted and cunning into dishonest practices, and tends in every way to demoralize the creamery industry.

"The creamery proprietor is not, however, the chief sufferer. He can always save himself and continue to profit by lowering the price of milk to correspond with the average quality of all received, as shown in the butter product. But the farmer who, producing milk of a superior quality from a herd which has cost much time and money to bring together, is obliged to pool with those producing inferior milk from scrub herds and poor feed—not to mention the possibility of home skimming or watering—he, by long odds, is the greatest sufferer."

The condition is little if any better where cream is paid for by the space or the pound. The Connecticut State Station found cream furnished by patrons of a creamery who set their milk in deep submerged cans for twelve to twenty-four hours to contain from 13.8 to 24.9 per cent of fat. The smallest variation noticed on any single day was from 19 to 21.9 per cent, or a variation of nearly 3 per cent of fat. As mentioned under *Creaming of milk*, the volume of the cream thrown up by a can of milk set in water is influenced by the temperature of the water in which the milk is set. Other examples might be given, but the above suffice to show the injustice of paying for milk or cream by volume or weight instead of by composition.

The introduction of reliable milk tests by which samples can be tested rapidly has made the payment on the basis of the quantity of fat furnished practicable, and schemes have been proposed for carrying this plan out which have already been adopted by a considerable number of creameries. Prof. Patrick proposes (*Iowa B. 9*) the "relative value plan" of paying for milk, which consists in taking a small sample of each patron's milk as it is weighed at the creamery each day, testing it for fat, and then by a simple calculation calculating the number of pounds of fat in the milk furnished. At the end of the month the patron is paid so much per pound for the fat he has furnished. It has been suggested by the Connecticut State Station (*B. 106*) that the creamery adopt an arbitrary standard, as 4 per cent of fat, and pay a fixed price per 100 pounds for milk of that composition. Then for each tenth of a per cent of fat above or below this standard composition a given amount per 100 pounds of milk would be added or deducted. This plan is intended to simplify the calculation at creameries where the milk is contracted for at a fixed price; but at coöperative creameries where the patrons are paid according to the receipts of the creamery for butter the plan would complicate the calculation. Prof. Patrick proposes to simplify the work of testing the milk by making composite samples of each patron's milk and testing these at the end of about a week. A jar is kept for each patron, and as his milk is weighed each day a small sample is taken out and placed in his jar. Some kind of milk preservative, *e. g.*, corrosive sublimate, is added to prevent the sample from souring. At the end of the week the milk in the jar is mixed thoroughly, sampled, and tested, the result showing the average percentage of fat in the milk brought by that patron during the week. From this and the amount of milk brought the amount of fat brought during the week is calculated quite accurately. Tables to facilitate the calculation of the amount to be paid each patron are given in *Iowa B. 9; Pa. B. 12; Vt. B. 16.*

Farrington (*Ill. B. 16*) has shown that instead of preserving the milk sample with corrosive sublimate, which is extremely poisonous, the sample may be allowed to sour, and at the end of the week a little powdered lye added, which dissolves the curd so that an average sample can be taken for testing.

Various devices have been suggested for taking the daily samples (*Ill. B. 14; Iowa B. 9; N. Y. Cornell B. 37; Vt. B. 21*). Theoretically, the sample taken should be proportioned to the quantity of milk bought, but the Vermont Station has shown (*B. 21*) that practically this is not necessary, and that it is better to take all the samples of a uniform size.

(*Del. B 9, R. 1889, p. 164; Ill. B. 9, B. 10, B. 14, B. 16; Iowa B. 11; Mass. State R. 1889, p. 73, R. 1890 p. 54; Nev. B. 16; Pa. B. 12; Vt. B. 16, R. 1888, p. 145; W. Va. R. 1890, p. 29.*)

Creaming of milk.—CREAMING IN GENERAL.—The fat in milk exists as minute globules in suspension. The size of the fat globules varies considerably according to breed, period of lactation, and other factors, but the statement that twenty-five average-sized globules placed side by side would be equal to the thickness of medium-thick letter paper and that a quart of milk would contain something like two million globules, gives an approximate idea of their minuteness. It is characteristic of the fat globules of Jersey and Guernsey milk to be relatively large and quite uniform in size, of those of Ayrshire milk to be small and variable, while the Holstein globules are small but quite uniform in size.

The separation of these globules in creaming is effected in several different ways, to be referred to below, but depends in every case upon the difference between the specific gravity of the fat globules and that of the milk serum (water and solids other than fat). Milk fat is relatively lighter, *i. e.*, it has a lower specific gravity, than water or the other milk solids. Anything which tends to increase this difference in specific gravity aids the creaming. In deep setting this is effected by low temperature, which makes the water (serum) specifically heavier. Milk containing large globules will cream more rapidly and completely than milk with small globules. The fat in the skim milk is made up very largely of small globules which fail to separate or rise as soon as the others. According to Babcock of the Wisconsin Station (*B. 18, R. 1889, p. 63*) milk, like blood, contains a material called fibrin, which coagulates after the milk is drawn, forming a network of fine elastic fibers which entangle the fat globules and hinder their separation. In blood the formation of these fibrin fibers causes clotting. The fibrin begins to form very soon after the milk is drawn and the clots of fat globules which it produces are soon visible under the microscope. Studies of the subject have indicated that the coagulation or formation of fibrin begins at the surface and in contact with the sides of the vessel; that it is hastened by any contact with a rough surface, by agitation and by exposure to air; and that it is retarded by heat, by cold, and by certain chemicals. As the clots of fat rise more difficultly than the free globules the creaming is most efficient when the conditions are such as to retard or prevent the formation of fibrin threads. In practice this may be best accomplished by setting the milk directly after milking in cold water in a vessel of bright metal which can easily be kept clean. The formation of fibrin is believed to present no hindrance to creaming by centrifugal separators, so that the latter method is the most efficient with milk that has been transported or delayed in setting.

H. Snyder of the New York Cornell Station (*B. 29*) found that in the case of several cows whose milk creamed difficultly, the thoroughness of creaming bore no relation to the amount of fibrin, *i. e.*, in these cases other factors affected the creaming quite as much as fibrin.

Trials at several stations have indicated that the feeding of cotton seed or cotton-seed meal may improve the creaming of milk set at 70° or in ice water, and that these foods also affect the butter, making it firmer and harder, and lighter colored.

Tests at the New York Cornell Station (*B. 39*) showed that aërated milk creamed nearly or quite as completely as untreated milk.

SHALLOW SETTING.—At the Illinois Station (*B. 18*) when milk was set 3, 6, and 9 inches deep in a room at about 70° F., the cream rose more rapidly and more completely for the 3-inch setting than for either of the others. The same station found that the loss in skimming milk set in pans was very much larger when the milk was skimmed after twelve hours than after twenty-four hours. The New York Cornell Station (*B. 20*) found twenty-four hours to be sufficient for shallow setting.

DEEP SETTING.—It has been calculated that in raising cream in submeregd cans 18 inches deep and skimming after twelve hours, the fat globules in the lower portion of milk must rise about 1½ inches per hour, but owing to the minuteness of these globules their comparatively slow progress is in fact relatively rapid, since it requires the smaller globules to move each second over a space two hundred times

greater than their diameter. If we suppose a balloon 25 feet in diameter rising with equal relative velocity it would rise about 1 mile per second. The larger globules reach the surface first; some of the smaller globules, as the microscope shows in skim milk, fail to reach the surface at all.

Comparisons were made at the Wisconsin Station (*B. 29*) of the Cooley and "shotgun" deep setting cans. These differ in the manner of skimming, the cream being removed from the latter with a conical dipper. Much more care was found necessary in skimming the shotgun cans, and the author suspects that in practice the loss with this can is greater than with the Cooley can. The same station found that the efficiency of creaming by deep setting in ice water was greatly influenced by the character of the herd. The average loss in fat in creaming per 100 pounds of milk set ranged from 0.08 to 0.324 pound with different herds.

The Connecticut State Station (*R. 1891, p. 120*) found the percentage of fat in cream brought by creamery patrons who set their milk in deep submerged cans for twelve to twenty-four hours to vary from 13.8 to 24.9, averaging 19.85 per cent. On one day the cream furnished by the patrons of a creamery ranged from 13.8 to 21 per cent of fat; on another from 18.3 to 24.9; and the smallest variation noticed at any one creamery was 19 to 21.9. This illustrates the injustice of paying for cream by the volume instead of by the composition, as referred to elsewhere.

A trial at the Vermont Station (*R. 1890, p. 113*) of adding soda to the milk to assist in creaming resulted disadvantageously both to the rising of the cream and the quality of the butter.

The Texas Station (*B. 14*) found that the milk of cows advanced in the milking period creamed less perfectly in deep setting at 70° and at 45° F. than that of cow nearly fresh.

As to the advantages of warming milk before setting, a number of tests at the Wisconsin Station (*R. 1884, p. 21*) of warming milk to 110°–120° F. showed no advantage over immediate setting and a positive loss in a majority of cases. Tests at the New York Cornell Station (*B. 5*) were not concordant, but indicated that "while there may not be any very great increase of butter when the milk is heated there is no risk of injuring the quality of the butter by incorporating an excess of casein even when the milk is heated as high as 135° F."

A description and trial of the Kellogg deep-setting system of creaming milk are reported in *Wis. R. 1885, p. 45.*

Temperature of deep setting.—At the New York State Station (*R. 1889, p. 210*) a comparison of submerging milk in cans in spring water at 56° F. and in ice water gave $\frac{3}{4}$ of a pound more butter per 100 pounds of milk from the use of ice. The Wisconsin Station (*R. 1884, p. 17*) found that the loss by setting in water at 55° might be nearly a third larger than at 45° and a tenth larger than 50°.

Snyder (*Minn. B. 19*) found that the first change in warm milk set in cold water took place in the bottom layer, which after fifteen minutes became poorer in fat. Throughout the creaming the upper layer of milk was always richer in fat than the middle layer, the middle layer richer than the bottom layer, and the latter layer was always the poorest in fat. This is of importance in taking the samples of the skim milk for analysis. During the first five or six hours the same relationship exists as to temperature, the middle section having an intermediate temperature between the bottom and top sections, which have, respectively, the lowest and highest temperatures. He also found that the temperature of the water at the time of setting was of much more importance than that of the milk; that creaming was more rapid and more complete in ice water than in water at 60° F.; and that "a prolonged setting can not make up for a low temperature at the time of setting."

Babcock (*Wis. B. 29*) concluded from trials with herd milk set at from 35° to 58° F. and skimmed after eleven or twelve hours, that the loss of fat per 100 pounds of milk was from $\frac{1}{2}$ to 1 pound larger without than with ice. "Where the temperature of the water used is not lower than 50° F. the loss is excessive, reaching in some cases as much as 25 per cent of the total fat in the milk."

Jordan (*Me. R. 1886–'87, p. 118*) found that the creaming was more complete at a temperature below 45° than at higher temperatures. About 9 ounces more of butter were obtained per 100 pounds of milk by setting at 48° or below than at 60°. That station found that in every instance the cream raised in cold setting was more voluminous but poorer in fat than that raised in moderately warm water, and that the cream was richer from twenty-four hours' than from twelve hours' standing with the colder setting. Tests in the Southern States have shown that ice can not be used there with economy.

DELAY IN SETTING.—Regarding the effect of delay in setting milk on the efficiency of creaming, the experiments made by the stations indicate that while no serious loss may be expected from delaying the setting for from one to three hours, it is advisable to set as soon as possible after milking to avoid the possibility of loss.

At the Wisconsin Station (*B. 29*) a large number of trials were made of delaying the setting from fifteen minutes to three hours and then setting the milk in open air or in ice water and skimming after twelve hours' standing. The delayed milk was mixed before setting. The losses were slight, but differed with different herds of cows, being as a rule somewhat larger with the rich milk than with poorer. No advantage was noticed from keeping the milk warm during the delay of thirty minutes. In similar tests on a smaller scale at the Maine and New York Cornell Stations, delaying setting from one-half to three and one-half hours did not materially affect the thoroughness of creaming, especially if the milk was kept warm (about 80° F.) in the meantime. When milk was allowed to cool before setting in the creamer, Roberts, of the New York Cornell Station, found that the creaming was less effective. Heating as high as 135° F. before setting did not injure the quality of the butter, and slightly improved the creaming. As a rule where the creaming is retarded in any way the volume of the cream will be larger than where it is not retarded, *i. e.*, the cream will contain more water, and so the percentage of fat will be lower. This was found to be true in a large majority of the trials at the Wisconsin Station. The matter of delay in setting has an important bearing on the fermentations of milk, provided the setting is in cold water (see *Milk fermentations*).

SKIMMING.—It was found at the Illinois Station (*B. 18*) that when milk was set in deep cans in water at 45° to 48° F. there was a small gain from letting it stand forty-eight hours.

Snyder (*Minn. B. 19*) found that with milk set in cans at from 47° to 60° F. the creaming was practically completed in twelve hours.

At the Kansas Station (*R. 1888, p. 159*) milk was set in glass fruit jars submerged in water at 60° F. Under these conditions "more butter of better quality was obtained when the milk was set about forty-eight hours."

The Wisconsin Station (*R. 1884, p. 17*) concluded that eleven hours was practically sufficient for raising the cream if the water was kept ice cold, and the Maine Station (*R. 1887, p. 116*) found twelve hours sufficient when the temperature was below 48° F. At higher temperatures there was advantage in allowing milk to stand twenty-four hours.

The Texas Station (*B. 14*) found that in cold deep setting at 70° and at 45° F. the milk of cows nearly fresh and others well advanced in the milking period creamed more perfectly in twenty-four hours than in twelve hours.

At the New York State Station (*R. 1889, p. 210*) twelve hours setting in ice water was found insufficient and twenty-four hours was adopted. As to the closeness of skimming milk set in Cooley cans, the Illinois Station (*B. 18*) finds that "drawing off the skim milk to within one inch of the bottom of the cream can be done without loss of cream if the faucet is set so that the skim milk does not stop running until closed; repeated opening and closing of the faucet has a tendency to mix the cream so that it flows out with the skim milk."

In tests at the Wisconsin Station (*B. 29*) the loss of cream was "practically the same whether 1 or 2 inches of skim milk were left with the cream. There is, however, a very material increase in the loss when another half inch of skim milk is drawn off."

(*Ala. College B. 7, n. ser.; Conn. State R. 1891, p. 110; Me. R. 1886–'87, p. 118, R. 1890, p. 46; N. Y. State R. 1885, p. 275, R. 1889, p. 210, R. 1890, p. 199; N. Y. Cornell B. 5, B. 29; Tex. B. 14; Vt. R. 1890, p. 111, R. 1891, p. 100; Wis. B. 29, R. 1885, pp. 45, 118.*)

CREAM RAISING BY DILUTION.—It has been suggested that in deep setting the separation of the cream may be improved by diluting the milk with water, and that by this means cream may be raised in deep cans without the use of ice. The results secured at the stations are somewhat at variance, as will be seen from the following.

The Illinois Station (*B. 12, B. 18*) has made two series of laboratory trials, using wide-mouthed bottles in each case, set in the open air. The milk was diluted with an equal volume of cold water. From ½ pint to a quart of the mixture was used in each test, filling the bottle from 4 to 8 inches deep. It was found that in the case of cows well along in milk or which gave a large quantity of moderately rich milk dilution with cold water hastened the creaming and made it more complete. Rich milk from a new milch cow creamed as completely without as with dilution. The cream raised by dilution under the above conditions was thinner, i. e., occupied a larger volume.

Both the Vermont Station (*Newspaper B. 3, R. 1890, p. 104, R. 1891, p. 103*) and the New York Cornell Station (*B. 20, B. 29, B. 39*) have made quite extensive experiments on this subject, setting the milk in deep cans in a Cooley creamer. In these experiments portions of the milk were diluted from one-fourth to one-half (by volume) with either cold or hot water (about 135° F.) and set along side of other portions which were not diluted. The temperature of the water in the creamer was varied, being in some experiments ice water (about 40°) and in others 55°–60°.

From a summary of its experiments the Vermont Station concludes that "there has been a gain in every case by diluting the milk when it was to be set at 60°, while at 55° there was a gain with cows fresh in milk but no gain with those far advanced in lactation."

The earlier experiments at the New York Cornell Station failed to show any advantages from dilution with either hot or cold water, but more recent experiments have been favorable to dilution when the milk was set at 60° F. The station concludes that "when milk is set at 60° or thereabouts there is considerable advantage so far as the efficiency of creaming is concerned, in diluting it one-fourth with warm water; but this dilution can not be regarded as a substitute for setting in ice water."

No advantage has been observed from diluting milk set in ice water and neither the New York Cornell Station nor the Vermont Station has observed any advantage from dilution with cold water over no dilution, whether the setting was in warm water, ice water, or the open air. The use of hot water has everywhere caused the cream to sour rapidly, in some cases affecting the quality of the butter. As the water which is added largely passes into the skim milk, dilution injures the skim milk for feeding purposes.

The New York Cornell Station reports a case in which the creaming of the milk of 5 cows, which creamed very imperfectly, was much improved by mixing it with an equal quantity of herd milk. Dilution with water did not aid the raising of the cream on this obstinate milk, but mixing it with herd milk had the effect of making it cream nearly as readily as the herd milk alone.

The Vermont Station found no advantage from diluting milk with either hot or cold water when the skimming was done after forty-eight hours' standing.

SEPARATING.—The creaming of milk by centrifugal force in separators is an improvement over setting in several respects. The fat is more completely separated than by any other means; conditions which affect the raising of the cream by setting

are largely or wholly overcome, and no ice is required, which is a very important consideration in localities where ice is expensive. By separating the milk immediately after milking, the danger from mischievous organisms (bacteria), which cause undesirable fermentations, is largely avoided.

The Vermont Station (*R. 1891, p. 40*) tested the efficiency of the De Laval Turbine, the Baby No. 2, the Sharples Russian, and the Danish-Weston separators, and the butter extractor. The average percentage of fat in the skim milk was 0.08 with the De Laval Turbine, 0.1 with the Baby No. 2, 0.23 with the Sharples Russian, 0.1 with the Danish-Weston, and 0.14 with the extractor when used as a separator. For an account of the extractor see *Butter extractor*.

In experiments at the New York Cornell Station (*B. 39*) the average percentage of fat left in the skim milk was 0.19 by the De Laval horizontal separator, 0.09 by the Baby separator No. 2, and 0.23 by cold deep setting.

Of the hand separators, the Delaware Station (*B. 17*) found little difference in efficiency between the Victoria and De Laval (Baby), and that they skimmed as closely as the power machines. Under proper conditions of temperature and speed the skim milk should not contain over 0.1 per cent of fat. The milk should have a temperature of about 70° F. to prevent clogging. With less than forty turns per minute of the De Laval crank and forty-six of the Victoria, the creaming was not efficient. The Victoria required about twice as much power to skim the same quantity of milk as the Baby separator.

In trials at the Pennsylvania Station (*B. 20*) the skim milk from the Baby separator No. 2 did not contain over 0.05 per cent of fat.

From a comparison of creaming the milk of a herd of registered Jerseys by means of the Cooley system and the De Laval separator, the Alabama College Station (*B. 7, n. ser.*) concluded that "under our conditions the centrifugal is more economical than the deep-setting system."

A comparison at the Wisconsin Station (*B. 29*) of the Cooley system with ice and the Baby separator, on different herds, gave results considerably in favor of the separator, the loss of fat by that method being only a third of that by cold setting. The Illinois Station (*B. 18*) also obtained better results with the Baby separator than by any method of setting.

The Texas Station (*B. 14*) has found that although the feeding of cotton-seed meal seemed to improve the creaming of milk set in cans, it had no effect on the thoroughness of centrifugal creaming.

Regarding the profit from the use of the separator, the Delaware Station (*B. 17*) calculates that with a herd averaging 100 pounds of milk morning and night the year through, the separator would save about 280 pounds of butter in the year, which at 25 cents per pound would be a gain of $70 over cold setting; "but if fair wages be counted for the hand labor, the profit would be much reduced if not wiped out." It is suggested that horse or other power be used in place of hand power.

The Berrigan separator is an apparatus in which the diluted milk is treated to an air pressure of 30 pounds for two minutes. The milk is then set in ordinary vessels, and it is claimed that the treatment facilitates the raising of the cream. The New York Cornell Station (*B. 39*) found little if any advantage from the treatment.

(*Del. B. 9, R. 1889, p. 164; Nev. B. 16; Tex. B. 5; W. Va. B. 13, R. 1890, p. 29.*)

Cream-raising.—See *Creaming of milk*.

Cream separators.—See *Creaming of milk*.

Cress.—Six varieties of cress (belonging presumably to *Barbarea* or *Lepidium*) were grown at the New York State Station (*R. 1884, p. 286, R. 1885, p. 191*). Germination tests of seeds are recorded in *N. Y. State R. 1883, p. 68; Ohio R. 1885, p. 168; Ore. B. 2; Vt. R. 1889, p. 104*. Tests of seed of water cress (*Nasturtium officinale*) are reported in *N. Y. State R. 1883, p. 71*.

Crimson clover.—See *Clover*.

Cucumbers (*Cucumeris sativus*).—Variety tests are recorded in *Ala. College B. 2 (1887); Colo. R. 1888, p. 147, R. 1889, pp. 100, 121, R. 1890, pp. 48, 192; La. B. 3, 2d ser.; Mich. B. 70, B. 79; Minn. R. 1888, p. 260; Nebr. B. 6, B. 12; Nev. R. 1890, p. 29; N. Y. State R. 1882, p. 126, R. 1883, p. 185, R. 1884, p. 206, R. 1885, p. 123, R. 1886, p. 239, R. 1887, p. 322; Ore. B. 4; Pa. B. 14; Utah B. 3; Vt. R. 1889, p. 137, R. 1890, p. 159.* In *N. Y. State R. 1887, p. 230,* a classification of varieties is given under twenty-four names, with full descriptions, synonyms, and index of synonyms. The snake cucumber, a long and slender form of the muskmelon and the West India gherkin, here regarded as a distant species of cucumber, are also described.

At the Arkansas Station (*R. 1890, p. 32*) the plan was tested of placing cucumber hills one on each side of a triangular pit filled with manure, other hills being placed in the same position without pits or manure. The average advantage from the pits in this experiment was not sufficient to recommend the plan. At the New York State Station (*R. 1885, p. 124*) the experiment was tried of pinching off the ends of the runners at the length of 2 or 3 feet. The yield at first was somewhat larger, but in the aggregate there was little difference. At the New York Cornell Station experiments were made in crossing and grafting cucumbers and other plants, for which see *Muskmelon.*

N. Y. Cornell B. 25 contains an article upon the forcing of English cucumbers, a group of very long, smooth varieties, which can only be grown indoors. The general requirements for growing them are discussed, descriptions of particular varieties and of the character of the group are given with historical notes of some length, together with an account of crosses undertaken at the station to secure improved field varieties and of the enemies to be overcome in culture. "The English forcing cucumber demands a rather high temperature, brisk bottom heat, abundance of water, and a very rich soil." Germination tests of cucumber seed are recorded in *N. Y. State R. 1883, pp. 59, 68; Ohio R. 1884, p. 197; Ore. B. 2; Vt. R. 1889, p. 104.*

Cucumbers, bacterial disease.—Usually the first indication of this disease, which infests all melons as well as cucumbers, is a decay near the root, followed by a wilting of the plant. Sometimes a leaf or two are first attacked and soon die, to be followed shortly by the whole vine. In the cucumber the fruit is more often attacked than the vine, but in either case both suffer. The indications of its presence are numerous watery spots on the fruit. These soon run through it, leaving a shell holding the watery rotten mass in shape. A microscopic examination would show this mass to be teeming with bacteria. That they are the cause of the infection has been demonstrated by numerous cultures and inoculations. It is also known that in addition to melons of all kinds this disease may be transmitted to the potato and tomato, causing them to rot in the same way. It is important that this be recognized and that infected land should not be used for crops subject to this disease. All diseased plants and fruits should be promptly removed to prevent, as much as possible, the spread of the disease where it once gets a start. Spraying with Bordeaux mixture is recommended as a preventive agent. (*N. J. R. 1891, p. 273.*)

Cucumber beetles.—The striped cucumber beetle (*Diabrotica vittata*) is one-fourth inch long and of a yellow color, with three black stripes on the back, one on each of the wings and the other on the edge of the wings just where they come together. The beetles feed upon cucumbers, melons, and squash vines by preference, but will eat quite a number of plants if their favorites are not to be had. They burrow at the roots to lay their eggs, and also to meet the young plant before it can reach the surface. The larvæ are similar to those of the spotted beetle, about two-fifths inch long and slightly thicker than an ordinary pin. The adult beetles probably pass the winter in the soil and under rubbish.

The ordinary treatment by means of poisons, kerosene, etc., has little effect upon these beetles. The free use of tobacco stems and dust about the hills seems to drive them away. Placing over the hill some kind of frame or tent and covering it with cheese cloth or similar thin goods is one of the best means of protection. Two half

hoops from barrels or two wires bent in a similar manner, with the ends stuck in the ground, make good frames for this covering and the cloth may be covered with earth at the edges. If protected in this way until they get four or five leaves the plants are generally able to withstand any subsequent attack of these beetles. (*Del. B. 4; Iowa B. 5; Ky. B. 40; Miss. B. 14; N. J. R. 1890, p. 480; N. C. B. 78; Ohio B. vol. II, 6, B. vol. III, 8 and 11; S. Dak. B. 13.*)

The spotted cucumber beetle (*Diabrotica 12-punctata*) is a small yellow beetle having twelve black spots upon its back. It is rather common, occurring on cucumbers, melons, squashes, and occasionally on corn and other plants. It is destructive as a larva and also as a beetle. It lays its eggs at the root of the plant and a small slender white grub hatches out to feed there. The beetle eats the leaves and stem. It is very destructive to the young plants. The treatment is the same as that for the striped beetle. (*N. Mex. B. 3; Ohio B. vol. III, 4.*)

Cucumbers, damping off (*Pythium de baryanum*).—A fungous disease attacking the plants while in the greenhouse or hotbed, where especial efforts have been made for forcing the plants. As in the case of a similar disease in the egg-plant its attack is near the ground. An examination at that part of the stem will show abundant threads of this fungus. The immediate removal and burning of any plants showing affection is urged. Probably early and repeated spraying with Bordeaux mixture or some other fungicide would prove beneficial. (*Mass. State R. 1890, p. 220.*)

Cucumber mildew (*Plasmopara* [*Peronospora*] *cubensis*).—A fungous disease which made its appearance very suddenly a few seasons ago and was very destructive to cucumbers and squashes. It is first seen as patches of fungus scattered over the leaves. These are not compact, as in many of the mildews, and are seldom visible to the naked eye. The leaf soon becomes yellow and lifeless and falls from the vine. This continuing from leaf to leaf soon involves the whole plant to a considerable extent. Its attack and spread may probably be prevented by ½ ounce of sulphide of potassium in a gallon of water, although no record is given of its having been tried. (*Conn. State R. 1890, p. 97; Mass. R. 1890, p. 210.*)

Cucumbers, spotting (*Cladosporium cucumerinum*).—A fungous disease first noticed at the New York State Station in 1887, where it ruined the crop of that year. The spots first appear upon the fruit when it is about an inch long, and show as gray, slightly sunken places usually about ⅛ of an inch across. These grow and run together, especially toward the flower end. Drops of a gummy substance frequently appear, as if caused by insect punctures. The spots grow darker with age, becoming greenish black, and form a small cavity just beneath the fungous covered surface. This is caused by the filaments penetrating the tissues of the plant. In this cavity the filaments grow rapidly, soon forming a mat of filaments and dried gum, from which are developed myriads of spores. These germinate rapidly in water thus spreading the disease. Although very destructive in 1887 no trace was seen of it in the following year. No fungicides have been tried upon it, but no doubt the more common ones would prove beneficial if applied in time. (*Ind. B. 19; N. Y. State R. 1887, p. 316.*)

Cucumbers, powdery mildew (*Erysiphe cichoracearum*).—A fungous disease confined so far to cucumbers grown under glass, although the fungus is well known and rather abundant upon some of our late-blooming plants, such as the asters, goldenrods, etc. It ordinarily appears upon the upper side of the cucumber leaf, sometimes on the stem, in the form of small, round, white spots of a peculiarly powdery appearance, suggesting small splashes of flour upon the leaves. These spots increase in size until the leaf is more or less involved. The tissues become yellow, then brown and dry and the plant becomes worthless if not entirely killed. The disease is rapidly spread from plant to plant, and healthy, vigorous plants are as liable to its attack as weaker ones. Where this disease becomes established the soil should be renewed and the greenhouse thoroughly fumigated with vapors of sulphur. The spraying of plants with ammoniacal carbonate of copper or 1 ounce of sulphide of potassium in

4 gallons of water will protect them from attacks of the fungus. In fumigating with sulphur care must be taken that it does not take fire, for a few minutes exposure to the fumes of burning sulphur will kill any plant. Heating the sulphur to the boiling point over a small oil stove is the best method to pursue. (*Mass. R. 1891, p. 2??.*)

Cucurbits (*Cucurbitaceæ*).—Vegetables of this family (cucumbers, melons, pumpkins, squashes, etc., are in general noted under their particular names, but some general experiments may here be referred to. As reported in *N. Y. Cornell B. 15*, "the belief that new or fresh seeds of squashes, pumpkins, and melons produce plants which 'run to vine' more than those from old seeds" was put to test at that station by an experiment in which about four hundred and fifty plants of squashes, watermelons, muskmelons, and cucumbers were grown and measured. No evidence whatever was obtained that older seeds give shorter and more productive vines.

At the same station (*B. 25*) experiments in herbaceous grafting showed that the muskmelon will unite with the watermelon, and both of these, as also the cucumber, with the wild cucumber (*Echinocystis lobata*). Observations with regard to the progression of flowers made upon squashes, muskmelons, watermelons, and cucumbers showed that the staminate flowers are from six to twenty-four times as numerous as the pistillate, and that the latter appear later, from five days in the cucumber to even thirty in the muskmelon.

For experiments in crossing pumpkins and squashes see *Squash*. For an experiment showing that muskmelons are not spoiled by cucumbers planted near see *Muskmelon*.

Curled dock.—See *Weeds*.

Currant (*Ribes* spp.).—Variety tests of the common red and white currants (*R. rubrum*) are recorded as follows: *Cal. R. 1888–'89, pp. 88, 110, 197; Colo. R. 1889, pp. 24, 30, R. 1890, p. 200; Del. R. 1889, p. 103; Ill. B. 21; Ind. B. 5, B. 10, B. 31, B. 33; Iowa B. 16; Me. R. 1889, p. 256; Mass. Hatch B. 4; Mich. B. 55, B. 59, B. 67, B. 80; Minn. R. 1888, pp. 235, 285; N. Mex. B. 2; N. Y. Cornell B. 15; N. Y. State R. 1883, p. 226, R. 1884, p. 22, R. 1885, p. 230, R. 1886, p. 257, R. 1887, p. 338, R. 1888, pp. 96, 101, R. 1889, p. 311, R. 1890, p. 282; N. C. B. 72; Ohio R. 1884, p. 129; Pa. B. 18; R. I. B. 7; S. Dak. B. 23; Tenn. R. 1888, p. 12; Vt. R. 1888, p. 118, R. 1889, p. 122, R. 1890, p. 184; Va. B. 2.*

While the number of varieties rises to a dozen or more, it is still questioned (*Mich. B. 80*) whether any are better than the old red and white Dutch. *Iowa B. 16* approves White Grape most highly for home use in northern Iowa, and the *Minn. R. 1888, p. 235* calls special attention to Stewart Seedling.

Ash analyses of red and white currants are given in *Mass. State R. 1889, p. 306, R. 1890, p. 305, R. 1891, p. 331.*

Notes on the manner of cultivating currants occur in *Iowa B. 16; N. Dak. B. 2*. At the New Jersey Station (*R. 1889, p. 231*) the experiment was tried of clipping at time of flowering the free end of the currant cluster, which usually dies. The berries on the stems thus treated were larger and of a nearly uniform size and ripeness. There were 15 per cent more berries per stem on the cut clusters, weighing 7 per cent heavier.

In *Mass. State B. 7* is reported an experiment with fertilizers upon currants, the object of which was to ascertain the influence of different chemical fertilizers upon the composition of the fruit. Four plats of bushes were dressed with various materials and combinations annually for several years, 1 plat being left unfertilized. The berries from the several plats were analyzed, with the general result that the highest color and the largest amount of vegetable matter and of mineral constituents was shown by the plat receiving 45 pounds dissolved boneblack, 18 pounds nitrate of potash, and 30 pounds kieserite. The analyses are given and discussed in some detail. The only ash constituent which appeared to be deficient in the soil was potash. A feature of the results deemed especially worthy of note was that the increase of potash in the currants was invariably accompanied by a corresponding decrease of phos-

phoric acid, and particularly of lime, a result coinciding with previous observations on grapes, strawberries, and peaches.

Tests of varieties of the black currant (*Ribes nigrum*) are reported in *Colo. R. 1889, pp. 24, 31; Ind. B. 10, B. 31, B. 33; Mass. Hatch B. 4; Mich. B. 55, B. 59, B. 67, B. 80; Minn. R. 1888, pp. 235, 285; N. Y. State R. 1883, p. 226, R. 1885, p. 230, R. 1886, p. 257, R. 1887, p. 339, R. 1888, pp. 96, 101; N. C. B. 72; Ohio R. 1884, p. 129; R. I. B. 7; Vt. R. 1888, p. 118, R. 1889, p. 122, R. 1890, p. 184; Va. B. 2.* The black currants are recommended more for jellies than for other purposes. In *Iowa B. 16* it is thought that the Black Naples "has a value not realized, except by our settlers from England. By scalding the fruit for a few moments in boiling water and then putting into fresh water for cooling, the peculiar flavor of the skin is removed, and when canned for winter use it is much like the cranberry sauce in flavor and color."

The Missouri or yellow flowering currant (*Ribes aureum*) besides being grown for ornament is represented in the fruit garden by some large-fruited varieties, especially the Crandall currant, a variety of which diverse opinions are expressed. It is noted in *Iowa B. 16; Mich. B. 55, B. 67, B. 80; R. I. B. 7;* and most fully in *N. Y. Cornell B. 15.* In the last named publication the fruits are described as large and fair, bluish black and polished; the flavor sweet and agreeable, though not pronounced, without the grossness of the common black currants. "It makes good stews, pies, and jellies whether used green or ripe. The variety is wholly distinct from every other. It represents a new type of small fruit, which, when further selected an d improved must come to be a staple." Other opinions are less favorable, owing perhaps to the variety being as yet not fully established.

A test of currant seed is reported in *Vt. R. 1889, p. 112.*

Currant borer (*Ægeria tipuliformis*).—The adult insect is a slender, rapidly flying, dark blue moth, having three yellow bands across the body and a yellow collar. The larva is white, with a brown head and a few hairs scattered over its body. The female moth lays her eggs toward the latter part of May and usually near a bud on one of the outer branches. As soon as hatched, the grub eats its way to the center of the stem and lives in the pith until the following year, when it emerges a moth. Pruning out and burning the affected canes, which are soon recognized, is the only safe means of protection. This species was imported from Europe. (*Colo. B. 6; N. Y. State B. 35; Ore. B. 5.*)

Currant leaf spot (*Septoria ribis*).—A fungous disease appearing about the middle of summer as whitish spots with dark centers, which soon spread over the leaf. The leaves drop prematurely, often the whole bush being naked by September.

Bordeaux mixture, ammoniacal carbonate of copper, and potassium sulphide solutions are recommended as having been successfully used to prevent this disease. (*Iowa B. 13; Vt. R. 1890, p. 143.*)

Currant worm, imported (*Nematus ventricosus*).—The adult insect is a small, four-winged fly, about the size of the common house fly. The male fly is black, with some yellow spots, while the female is a bright honey yellow, with a black head. During late spring and early summer the female lays her eggs in regular rows along the under side of the veins of the leaves. The eggs hatch in about four days. The larvæ feed, molt, and within eight days burrow into the ground, where they remain about thirteen days before emerging as adult flies. Two broods appear during a season. When full grown the larvæ are almost three-fourths inch long, and green, with numerous black spots. Just before leaving the bushes they shed their skins and are then light green, with sometimes yellow extremities. The last brood after leaving the bushes go into the ground, where they remain until the following spring. This species is generally known as the imported currant worm, to distinguish it from a native species, *Pristiphora grossulariæ,* of similar habits.

White hellebore, a teaspoonful in a gallon of water, sprayed over the bushes just as the worms begin their first attack, and again in about ten days, will usually kill all the worms; if not, a third application will surely do so. If preferred, the helle-

bore may be mixed with flour and dusted over the bushes. Be sure to get it on the under side as well as on the upper side of the leaves. (*Ky. B. 40; Me. R. 1888, p. 182; Mass. Hatch R. 1888, p. 25; Mich. B. 76; N. Y. State B. 35, R. 1888, p. 146, R. 1889, p. 333; Ohio B. vol. II, 1, 6, R. 1888, p. 152; W. Va. R. 1890, p. 153.*)

Cutworms (*Agrotis, Hadena,* and *Mamestra* spp.).—There are a large number of species, the larvæ of which are called cutworms, from their habit of cutting off plants. The most numerous and common ones belong to the genus *Agrotis*, of which about twenty-five species are mentioned in station literature. The adult is a night-flying moth or "miller," well known as fluttering about lights in summer. They are mostly of somber color, gray and brown predominating. They are an inch or two across their wings and are rapid fliers. They lay many eggs which hatch out greenish, greasy looking worms. These hide during the day either in the ground or under rubbish and do their mischief at night. They attack quite a range of plants, often causing serious losses. One of the most successful means of destroying these pests is by scattering fresh clover or cabbage leaves, which have been soaked in Paris-green water, over the ground before setting plants. If this is done a few times and the leaves are changed every day or two but little loss will be experienced. Hand catching in the morning by digging them out of the ground is advantageous. They will be found a few inches from the plant attacked during the night. Planting more seed and plants than usual, leaving the worms to do the thinning, is sometimes tried. Salt and copperas water may be used. Salt should be used sparingly about plants as it will kill some if too much be used. Setting cones of tin or tar paper about the hills will protect the plants within. The tin or paper may be slightly sunken in the ground and allowed to stand up like a collar 2 or 3 inches above the surface. Holes an inch in diameter and 3 or 4 inches deep will trap many. (*Ark. R. 1889, p. 142, R. 1890, p. 70; Del. B. 12; Fla. B. 9; Iowa B. 5, B. 11, B. 12, B. 18; Ky. B. 40; Nebr. B. 5, B. 16; N. C. B. 78; Ore. B. 5, B. 18; S. Dak. B. 13, B. 18.*)

Cypress (*Taxodium distichum*).—The bald cypress, though a native of swamps and river lowlands, in the experience of the Kansas Station (*B. 10*), was perfectly hardy on dry uplands. Set when two or three years old, at the end of eighteen years it was 23 feet high, and every way a handsome and healthy tree. It is a deciduous tree, more striking than beautiful when the foliage is off; but when in leaf, especially in spring, is rendered attractive by its rich, yellowish-green, feathery foliage. The twigs were occasionally injured in winter, but the tree endured the hot, dry weather apparently as well as most of the natives.

Dairy apparatus.—For butter extractor see *Butter extractor*. For separators see *Creaming of milk*. For milk and cream coolers and aërators see *Aërator*. For apparatus for testing milk see *Milk tests*. For creamers see *Creaming of milk*. For churns see *Churning*. For description of milk tests and devices for use in connection with milk testing at creameries, cheese factories, etc., see *Milk tests* and *Creameries*. (*Del. B. 9; Minn. R., 1888, p. 109; Nev. B. 16; Vt. B. 27; W. Va. B. 4.*)

Dairy buildings.—Descriptions of dairy and creamery buildings, usually accompanied by plans, have been published as follows: *Ala. College B. 5; Nev. B. 16; N. Y. Cornell B. 1; N. C. B. 68; Ontario* (*Can.*) *R. 1890, p. 54; Tex. B. 5; W. Va. B. 4.*

Dairying.—Work in dairying is carried on at 30 stations. This includes investigations of the separate processes of butter-making and cheese-making; the losses in these processes and means of eliminating them; the effect of food, and of the quality of milk on the composition and yield of dairy products; tests of dairy machinery and apparatus; the utilization of the waste products of the dairy; management of creameries; and various matters relating to the handling of milk. Accounts of the work in these separate lines are given under *Butter-making, Cheese-making, Creaming of milk, Churning, Creameries, Cheese factories, Milk tests, Dairy products, and Dairy apparatus.*

Dairy products.—COMPOSITION.—The Vermont Station (*R. 1891, p. 118*) gives the following as the average of American analyses of dairy products:

Average composition of dairy products.

	Total solids.	Fat.	Casein.	Albumen.	Milk sugar.	Ash.
Whole milk:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Average	13.00	4.00	2.60	0.70	4.95	0.75
Maximum	17.00	8.00	3.60	0.90	5.50	0.90
Minimum	10.00	2.00	1.60	0.40	4.00	0.60
Skim milk	9.75	0.30	2.75	0.75	5.15	0.80
Cream	25.95	18.80	2.00	0.50	4.15	0.50
Buttermilk	9.50	0.50	2.40	0.60	5.30	0.70
Whey	7.03	0.50	0.15	0.78	5.00	0.60
Butter	80.90	85.00	0.60	0.15	0.00	0.15
Cheese	66.75	35.50	24.65	0.00	4.50	2.10

Fertilizing ingredients in dairy products.

	Nitrogen.	Phosphoric acid.	Potash.
	Per cent.	*Per cent.*	*Per cent.*
Whole milk	0.53	0.19	0.175
Skim milk	0.56	0.20	0.185
Cream	0.40	0.15	0.130
Buttermilk	0.48	0.17	0.158
Whey	0.15	0.14	0.181
Butter	0.12	0.04	0.036
Cheese	3.93	0.60	0.120

Dandelion.—Attention is called in the *Minn. R. 1888, p. 262,* to the importance of this plant, grown as greens for the market or for private use. The superiority of the large-leafed double variety is pointed out, and directions are given for general culture and for forcing. The seed is to be sown early in the spring, the plants cultivated through the growing season and slightly mulched during the winter, when they will be ready for cutting early in the spring. It is held to be best to sow every year.

At the New York State Station (*R. 1887, p. 354*) a comparison was made of the variant forms of the wild and cultivated dandelion to see whether there is a correspondence between them. The wild were found to form four classes, specimens of which were transferred to the garden. When well grown none of the plants approached the cultivated varieties in shape of leaf or habit of growth. The chief change during growth, aside from increase in size, was the greater or less dissection of the leaves.

A germination test of dandelion seed is recorded in *Vt. R. 1889, p. 104.*

Date palm (*Phœnix dactylifera*).—This tree was found quite hardy at the California (Berkeley) Station (*R. 1880, p. 66*) even as a seedling. In *Cal. R. 1882, p. 102,* it is the subject of favorable discussion. While it will not ripen fruit at Berkeley on account of its proximity to the sea and its cool summers, it is believed that there are many localities in the State where it would ripen fruit and be a great acquisition. Good-sized trees of this palm will bear cold below 18° F., provided it comes between November and March; the hot winds of the desert do not injure it, and it will thrive in a climate too hot for any other known fruit tree if supplied with water,

even alkaline. The date palm is especially adapted to the southern part of the great San Joaquin plains wherever water can be procured. Suitable varieties must be obtained as cuttings and roots; growing from seed can not be relied upon. *Cal. R. 1890, p. 221,* contains correspondence from parties who had received seedling date palms, which in many cases were doing well. It is also grown as an ornamental tree. The date palms (the above and *P. canariensis*) have a much wider range in California than has been ordinarily understood, the fruit being set as far north as the head of the Sacramento Valley.

Dehorning cattle.—The practice of dehorning cattle has been quite generally advocated by the stations which have tried it. It appears that if properly done the operation need not necessarily be cruel or very painful. The animals have usually recovered from all ill effects of the operation in a few days. The practice materially lessens the danger of animals injuring each other, especially in transportation, and is strongly recommended in case of quarrelsome or vicious animals.

Cauterizing with potash or soda has been successfully tried for preventing the growth of horns in young calves (*Wis. R. 1891, p. 289; N. Y. Cornell B. 54.* This method appears to be effective, cheap, easy of application, and almost painless when carefully applied.

As to the temporary effect of dehorning on the milk see *Milk, composition.*

(*Ark. R. 1888, p. 22; Minn. B. 19; Miss. B. 10; N. Y. Cornell B. 37; Tenn. B. Vol. I, 1; Tex. B. 6; Wis. R. 1886, p. 19, R. 1888, p. 142, R. 1889, p. 57, R. 1991, p. 289.*)

Delaware Station, Newark.—Organized in May, 1888, as a department of the Delaware College under the act of Congress of March 2, 1887. The staff consists of the president of the college, director, botanist, meteorologist, horticulturist and entomologist, and chemist. The principal lines of work are chemistry, field experiments with crops, horticulture, diseases of plants and animals, and dairying. Up to January 1, 1893, the station had published 3 annual reports and 19 bulletins. Revenue in 1892, $15,000.

Devon cows.—See *Cows, tests of dairy breeds.*

Dewberry.—A thorough investigation of the dewberries in this country is reported in detail by the New York Cornell Station (*B. 34*). The name in its popular sense is referred to all trailing blackberries, but the best distinction between the dewberries and bush blackberries lies in the flower cluster, which in the former is cymose, the central flower opening first, and has but few and scattered flowers. The cultivated dewberries are derived either from the Northern *Rubus canadensis* and its varieties, Windom, Lucretia, Bartel, etc., or from the Southern *R. trivialis,* including the Manatee, etc. The peculiar merits of the dewberries as cultivated fruits are their earliness, large size, attractive appearance, and easiness of protection in winter; their peculiar demerits are failure of flowers to set, formation of nubbins, and difficulty of picking fruit. This fruit is believed to be an acquisition, though not likely to prove as popular as the blackberry. Twelve varieties have been named, of which those mentioned above are the best. The Windom is promising for the Northwest; the Lucretia has been found profitable over a large territory, but not uniformly; the Bartel has found favor with some growers from Wisconsin to Nebraska; the Manatee is probably valuable for the South.

VARIETIES.—Tests commonly of 1 to 3 varieties are noted in *Ind. B. 10; Mich. B. 67; Minn. R. 1888, p. 235; N. Y. State R. 1886, p. 257, R. 1888, p. 100; N. Dak. B. 2; Ohio R. 1886, p. 192; R. I. B. 7; Vt. R. 1888, p. 117, R. 1889, p. 122.*

For an experiment in cross-fertilizing with blackberries and raspberries see *Blackberry.*

Dhoura.—See *Durra.*

Digestibility of feeding stuffs.—See *Foods, digestibility,* and *Feeding farm animals.*

Dock.—See *Weeds.*

Dodder.—See *Weeds.*

Dogwood (*Cornus florida*).—A small tree, with showy white flowers in spring and very hard, tough wood, too small for use except for tool handles. It is briefly described in *Ala. College B. 2, n. ser.* The fuel value of its wood has been determined as reported in *Ga. B. 2.* Ash analyses of the wood and bark are also given. For partial analyses see *Appendix, Table V.*

Drainage.—Drainage in one form or another has long been recognized as essential to successful farming. The excess of water in soils must be gotten rid of before crops can be successfully grown. The oldest and most generally practiced method of accomplishing this even at the present time is some system of open drains or ditches. Improvements on this method have been gravel or rock drains (ditches partially filled with rocks and covered over); drains similarly prepared except that brush, poles, or sods are substituted for stone; and finally tile drains which accomplish thoroughly the desired object of gradually but effectually disposing of excessive rainfall and of keeping the soil warm, mellow, and tillable.

Open ditches.—Open ditches possess the advantages of cheapness and ease of construction. On the other hand they carry away much of the fertile surface soil in removing the excess of surface water while contributing little to the drainage of the lower depths of the soil. They are, however, the only means of drainage available in many cases. The proper construction of hillside ditches is described and illustrated in *N. C. B. 71.*

Tile drains.—It is admitted that all the advantages of thorough drainage under ordinary conditions are obtained by the laying of baked clay tiles at depths of from 2 to 4 feet, at intervals of from 20 to 30 feet, and with a fall sufficient to insure flow of the drainage water. Some details of construction are given in *Md. R. 1890, p. 102.* The most serious drawback to the extended use of this system of drainage is the large first cost. In experiments at the Texas Station (*B. 16*) in laying 3-inch tiles at varying depths the cost per rod was found to be as follows: 20 inches, \$0.88; 2½ feet, \$1.12; 4 feet, \$2.17. The cost may vary in different cases from \$25 to \$50 per acre, but when properly laid the tile drains last indefinitely, and it has been the common experience that the advantage from the use of land which would otherwise be wasted in open ditches and drains and from increased yield and improved quality of crops from tile-drained lands in a few years repays the cost of laying tiles.

Effects of drainage.—The most obvious result of drainage of course is the removal of the excess of water from the soil. The promptness with which this is done by tile drains is illustrated by observations at the Alabama Canebrake Station (*B. 3, B. 6*). From October 22–25 the rainfall on 3 acres of tile-drained land was 305,148 gallons; the outflow observed October 24–29 was 208,353 gallons, or 68 per cent. Similar observations on the same land in April of the next year showed an outflow equal to 23 per cent of the rainfall. The promptness with which the drains carry off excess of water tends to mitigate floods. This is not true of open ditches, as shown by investigations at the Michigan Station (*R. 1889, p. 76*). Observations by this station show that open ditches, together with deforesting increase floods, while tile draining, although it may increase flood in the spring and winter when moisture conditions are unusual, in the warm months mitigates both flood and drouth. The prompt removal of the excess of water warms the soil (*Ala. Canebrake B. 6, B. 10*) and puts it in a condition which permits the roots of plants to grow freely and draw water and plant food from a greater area.

In experiments at the Texas Station (*B. 16*) with cabbages and potatoes on tiled and untiled land, the results were highly favorable to the drained plats both as regards earliness, yield, and quality.

Results obtained at the Louisiana Station (*B. 7, B. 20*) on sugar cane bear on this point. The average increase in tonnage on tiled plats was in 1887, 24.2 per cent; in 1888, 34.5 per cent. The increase of available sugar was 23 per cent and 27.5 per cent, respectively. At the Mississippi Station (*R. 1888, p. 31*) the advantage of tile drainage for silage corn was 3,552 pounds, or \$6.10 per acre. In *Mass. State R. 1890,*

p. 192, is given an account of experiments in which an unsightly swampy meadow, covered with a comparatively worthless vegetation, has been brought up by the aid of tile-draining to a yield of 3 to 4¾ tons of good hay per acre.

EFFECT OF MANURES ON DRAINAGE.—The mechanical effect of bulky manures, such as barnyard manures is, of course, to make a soil light and to facilitate percolation. Another explanation of the improvement of the drainage of soils by manures is suggested by Prof. Whitney (*S. C. R. 1889, p. 64; Md. R. 1891, p. 257*). The surface tension of the soil water is reduced by the substances dissolved from the manure. This causes the smaller soil particles to adhere closely to the larger, thus opening the pores of the soil and permanently improving the drainage. As we have already seen under *Clay*, ammonia and the caustic alkalies tend to prevent this flocculation of soil particles, thus making the soil close and retentive, and lime produces the opposite effect, improving the drainage of close, wet soils.

COMPOSITION OF DRAINAGE WATER.—That the drainage water removes from the soil a certain amount of all of the fertilizing elements is shown by analyses made at the Massachusetts State Station (*R. 1883, p. 27*) of the drainage water collected May 22 from tiles laid under plats of worn soils.

Nitrogen as ammonia	parts per million	0.07- 0.42
Nitrogen as nitrates	do	0.05- 0.27
Potassium oxide	do	0.43-44.00
Phosphoric acid		trace

It will be observed that the loss falls heaviest on the nitrogen and potash. The examination was made at the season when the proportion of nitrates is smallest in soils, otherwise the amount of nitrogen would probably have been much larger.

SOILS WHICH NEED DRAINAGE.—The larger part of all agricultural soils need drainage of some kind, although the nature and value of the land in each case must determine how far this system of improvement can be profitably carried. On the damp, retentive, black slough canebrake soils of Alabama it has been found that "drainage pays better than manuring and pays permanently and annually." On the other hand experiments in tile drainage at the Missouri Station (*B. 14*) on rolling clay upland have not given decisive results either for or against the system.

It has already been explained under *Alkali soils* how essential drainage is to the improvement of such soils. The unusual fertility of such soils renders the laying of tile drains in many cases a good investment (*Cal. B. 83*).

(*Ala. Canebrake B. 3, B. 5, B. 6, B. 10, B. 13; Cal. B. 83, App. to R. 1890; Fla. B. 14; La. B. 7, B. 20, B. 17, 2d ser.; Md. R. 1890, p. 102, R. 1891, p. 257; Mass. State 1883, p. 27, R. 1890, p. 192; Mich. R. 1889, p. 76; Miss. R. 1888, p. 31; Mo. B. 14; N. H. R. 1888, p. 91; N. C. B. 71; Tex. B. 16.*)

Dried blood.—See *Fertilizers.*

Duroc-Jersey pigs.—See *Pigs, breeds.*

Durra (*Sorghum vulgare* or *Andropogon sorghum* var.) [variously spelled dhoura, doura, etc.].—A kind of non-saccharine sorghum similar to Kaffir corn and millo maize. Durra (locally known as Egyptian corn) has been grown in California for many years and has proved of great value as green forage for stock in summer. The seed is widely used for poultry and to some extent as a substitute for barley as horse feed. It does best in the interior valleys, especially in the upper Sacramento Valley. On the coast it does not mature (*Cal. R. 1878-'79, p. 93, R. 1890, p. 210*).

The experience of the Kansas Station (*B. 18*) with durra and other non-saccharine sorghums favors planting them in drills and cultivating as for corn. The rows should be 3 feet apart, the stalks 4 to 8 inches apart in the row. While a larger yield can be obtained by closer planting cultivation is rendered more difficult. As soon as the seed becomes hard the crop should be cut and shocked. By cutting off the seed heads the fodder is more easily handled. For feeding purposes the grain should be threshed out and ground fine and the fodder should be fed in racks. The variety known as brown durra as grown at the Kansas Station requires a full season in which

to mature and is liable to injury by early frost. The plants grow vigorously and stool profusely, from 5 to 10 full stalks growing from a single seed. The stalks are tall, coarse, and short jointed, with very heavy foliage. The heads are heavy, short, and thick and hang pendant on a short "goose neck." The seed is light yellow, slightly flattened. In 1889, a favorable season, the yield per acre was 13½ tons of dry fodder and 40 bushels of seed.

At the Louisiana Stations (*B. 8, n. ser.*) white durra grows to a height of 8 to 10 feet with a head 12 to 14 inches, weighing 6 to 8 ounces. If cut and cured when the seed is in the dough it makes an easily cured forage which keeps well in outdoor shocks and is relished by stock through the winter. It is also excellent as green fodder and more than one cutting can be made in a season. In the climate of Louisiana it matures in from 90 to 100 days. At the North Louisiana Station it produced 12½ tons of dry fodder and 43 bushels of seed in 1890.

At the Nebraska Station (*B. 12*) durra grows well and yields a large amount of seed.

An analysis of the ash made at the Texas Station (*B. 20*) gave the following percentages of fertilizing constituents: Lime 2.32, magnesia 16.77, phosphoric acid 40.71, sodium oxide 4.45, potash 26.88. The same station reports an analysis of silage made from durra (*Tex. B. 13*). For food constituents of brown durra see *O. E. S. B. 11.*

Dynamometer tests of farm implements.—A dynamometer is an apparatus for measuring the amount of force expended in moving a load or operating a machine. Tests of farm implements have been made with the dynamometer by Prof. Sanborn at the Missouri and Utah Stations. Among the results of these trials are the following:

HARROWS.—Rolling cutters, especially cutaway harrows, loosen the soil deepest; spring-tooth harrows till to a medium depth but leave the under soil uneven and compact; square-toothed and smoothing harrows do not stir the soil deeply but compress it more than the other harrows. Harrows move less earth for a given amount of force than plows do, but less force is required to fit a given surface area of soil for crops with the harrow than with the plow (*Mo. B. 4; Utah B. 6*).

MOWING MACHINES.—A 6 foot cutter bar drew more easily per foot than a 4¼ foot cutter bar; a pitman box set tight gave a less draft than one run quite loosely. Draft was decreased when the cutter bar was inclined upward and increased when the cutter bar was not near right line with the pitnam rod, when the guards were not true, and when the sections of the sickle did not strike in the center of the guard (*Utah B. 7*).

PLOWS.—Colters increased and trucks under the beam decreased draft. A poorly sharpened share drew harder than a dull one. No loss of draft was found when the share was made straight on its base or on its land side. A three-wheeled sulky plow without pole gave a light draft. Walking plows drew only a little easier than sulky plows with rider. The wider the furrow up to the standard cutting width of the plow the less the force required to turn a square inch of soil (*Mo. College B. 32; Utah B. 2*).

SLEDS drew harder than wagons over the same ground; change of load from the front to the rear end of the sled did not effect draft (*Utah B. 6*).

WAGONS.—When the load was placed over the hind wheels it drew 10 per cent easier than when it was placed over the front wheels. The incline of the reach toward the front wheels increases the draft. Higher front wheels will reduce draft. A long hitch increases draft. Loose burrs decrease draft. Draft varied with the kind of axle grease used, lard being the best kind tried. The draft on different roads varied very greatly, the difference between the best and poorest local roads being nearly 300 per cent (*Utah B. 4*). The importance of good roads and the advantages of broad-tired wheels for farm wagons are shown in tests reported (*Mo. College B. 13*).

Eau celeste.—See *Fungicides.*

Eggplant (*Solanum melongena*).—Tests of varieties are reported in *Colo. R. 1888, p. 136, R. 1890, p. 212; Nebr. B. 6; N. Y. State R. 1883, p. 192, R. 1886, p. 243, R. 1887,*

p. 273; N. Y. Cornell B. 26. A brief note on the availability of the eggplant for culture in Florida occurs in *Fla. R. 1891, p. 18.*

In *N. Y. State R. 1887, p. 273,* a classification of varieties numbering 12 is given, with full descriptions, English and foreign synonyms, and an index. The varieties were found to be generally distinct, and separable into four classes according to their purple, striped, white, or scarlet fruit.

A classified description of 14 varieties, with illustrations, is given in *N. Y. Cornell B. 26,* where also the botanical relations of the plant are shown.

At the New York State Station (*R. 1886, p. 158*) the main roots of a specimen examined were found to radiate from the stem at various angles, but in the larger number of cases inclined to be perpendicular.

In *N. Y. Cornell B. 26* directions are given for the culture of the eggplant in the North, which is regarded as quite feasible. An account is also there given of experiments in crossing. Numerous crosses in three series were obtained of varying degrees of promise.

In *B. 25* of the same station experiments in herbaceous grafting were reported, in which, among other results, eggplants, tomatoes, and peppers were found to grow upon the European husk tomato (*Physalis alkekengi*) and peppers and eggplants to unite reciprocally.

Germination tests of the seed of the eggplant are reported in *N. Y. State R. 1883, pp. 60, 69; Ohio R. 1885, pp. 168, 176; Ore. B. 2; S. C. R. 1888, p. 83; Vt. R. 1889, p. 104.*

Eggplant anthracnose.—See *Anthracnose of eggplant.*

Eggplant, ashy mold (*Botrytis fascicularis*).—A fungus disease of the fruit. It begins with a change, in spots, to a tan color, followed by a rapid softening and development of gray mold over the surface. The whole fruit finally becomes a rotten mass. This disease is liable to cause great loss after the fruit has been marketed. Bordeaux mixture is recommended for this disease. (*N. J. R. 1890 p. 357.*)

Eggplant, damping off or seedling stem blight (*Phoma solani*).—A fungous disease, showing itself in the hotbed, or soon after the plants have been transplanted. It is called "damping off" on account of its occurring near the ground, at which point the young plants decay and break down. Plants only slightly affected will make a feeble growth, but finally become worthless. Many specimens may be found completely girdled by the fungus. The diseased portion is discolored, shriveled, and hard. Spraying with Bordeaux mixture or ammoniacal carbonate of copper, begun when the plants are quite small, will, to a great degree, prevent this disease. (*N. J. R. 1891, p. 277.*)

Eggplant, leaf spot (*Phyllosticta hortorum*).—This fungus causes large brown, lifeless, patches in the leaves, and recently has been found to affect the fruit. The leaf spots are first indicated by a pale yellowish color followed by brown or gray dead patches, over which small dark specks develop. The tissue afterwards breaks up, leaving a hole. Upon the fruit soft somewhat sunken patches develop, and over these the small pimples as on leaves. The fungus spreads until the whole fruit is involved. The same fungicides are recommended as for "damping off" and the continuation of the treatment begun in the hotbed will usually result in preventing any attack from fungi. Diseased plants should be destroyed to prevent the spores infecting the ground for the next year's crop. (*N. J. R. 1891, p. 279.*)

Eggplant, stem rot (*Nectria ipomœa*).—Although known but a very short time, wherever this fungous disease has appeared it has proved very destructive. Its presence is manifested by the plants, when about half grown, becoming yellow and sickly in appearance. The leaves wilt and usually the plant soon dies. If the stem be examined near the ground it will be found covered with a white mold which extends below ground. Clustered upon the decayed surface will be found minute pink bodies, the spore cases of the fungus. It has been recently demonstrated that this fungus attacks the sweet potato in the same way. Nothing is known as a preventive remedy as yet. (*N. J. R. 1891 p. 281.*)

Eggs.—See *Poultry.*

Egyptian rice corn (*Sorghum vulgare* or *Andropogon sorghum* var.).—A variety of non-saccharine sorghum similar to durra (see *Durra*). As grown at the Kansas Station (*B. 18*) this plant tillered very little and had stalks of moderate height with rather long joints and few leaves. The heads were large and the seeds white, large, and sweet. In 1890 this crop yielded 3½ tons of dry fodder and 16½ bushels of clean seed per acre. The seed ripens early and is excellent for feed. It should be cut before ripening, as much of it is lost if allowed to mature before cutting. It seems to be a favorite food of English sparrows.

At the North Louisiana Station (*B. 8, n. ser.*) in 1890 Egyptian rice corn grew 4 to 6 feet high and yielded 11 tons of dry fodder and 22 bushels of seed per acre.

Elder rust (*Æcidium sambuci*).—A fungous disease rather common some seasons upon the common elder and the cultivated and ornamental varieties. It occurs upon the leaf stalks and leaves, causing abnormal growths of a fleshy character. These contain the spores and greatly distort the leaves. But little is known of the life history of this fungus. What has been observed is considered a phase only, and the other host or hosts upon which its cycle is completed are unknown. But little can be done towards overcoming it until all phases are known. To cut out and burn all parts affected is the only suggestion regarding treatment to be given at present. (*Mass. R. 1890, p. 223.*)

Electroculture of plants.—Two classes of experiments have been carried on in this country and Europe with a view to determining whether electricity may be used to aid in the culture of plants. In one class are the experiments in which electric currents are transmitted directly to the growing plant, usually by wires placed in the soil; in the other class are the experiments in which the electric light is used at night to determine the effects of prolonged exposure to light on the growth of plants.

In *Mass. Hatch B. 16* is given a brief résumé of European investigations on the effect of electric currents on the growth of plants and a report on experiments at the station with lettuce and grasses grown under the influence of dynamical electricity. A considerable number of the European investigations seem to show that electricity may aid in promoting the vigor and health of certain kinds of plants. Similar results were obtained at the Massachusetts Hatch Station. The lettuce plants "subjected to the greatest electrical influence were hardier, healthier, larger, had a better color, and were much less affected by mildew than the others. Experiments were made with grasses, but no marked results were obtained."

In *N. Y. Cornell B. 30* is given a résumé of experiments in Europe to determine the influence of the electric light on the growth of plants, and an account of similar experiments with several kinds of vegetables and ornamental plants at the station. In the latter a naked arc light was run either all or a part of the night, or a light protected by an opal globe was run all night. The naked light running all night hastened maturity, but injured some plants and in no case was found profitable; the naked light running a part of the night benefited lettuce and some other plants; the protected light run all night produced similar but less marked effect than the naked light. In further experiments recorded in *N. Y. Cornell B. 42* an arc light covered with a clear glass globe was hung above the greenhouse and run for a part of the night. Lettuce was greatly benefited by the light; radishes, beets, and spinach were somewhat benefited; cauliflower tended to grow taller and make fewer and smaller heads; violets and daisies bloomed earlier; with endives the results were negative.

Elms (*Ulmus* spp.).—The white elm (*U. americana*), called also swamp and water elm, is an approved forest and ornamental tree in the West, as noted at several stations. According to *S. Dak. B. 29*, "the elm seems to be especially adapted for cultivation in prairie regions. It is hardy and a rapid grower. It has several peculiarities in youth which are apt to bother the grower. The first is a tendency to form forked

branches, the two parts being of such equal strength that one is tempted to begin pruning at once." In large trees, however, one branch always gets the lead of the other. The jack rabbits injure this tree worse than others by girdling, the tough bark being torn off in strips. Notes on the white elm, with favorable testimony, are also contained in *Minn. B. 24; Iowa B. 16; Nebr. B. 18.* In *Minn. B. 24* are noted also the English elm (*U. campestris*), which was quite promising where on trial in that State; the red, slippery, or moose elm (*U. fulva*), considered desirable for forest, but less so for street planting; weeping slippery elm, an ornamental variety of the red elm; cork or rock elm (*U. racemosa*), with hard, strong wood, recommended for ornament and timber; camperdown weeping elm, a variety of the European *U. montana*, a very beautiful weeping tree found hardy at the station, though not generally so regarded in the State. In California the European cork elm (*U. suberosa* or *U. campestris* var. *suberosa*) does remarkably well as a shade tree (*Cal. R. 1888–'89, p. 48*).

"The so-called Japanese elm (*Planera cuspidata*) succeeds well on the coast, but like other Japanese deciduous trees, suffers somewhat from our hot and drying north winds (*Ibid, p. 49*).

Emperor moth, cecropia (*Attacus* [*Platysamia*] *cecropia*).—The adult insect is one of the largest as well as handsomest moths. It not infrequently measures 6 inches across its wings. The prevailing color is brown, each wing bearing near the middle a kidney-shaped white spot, shaded with red and edged with black. The caterpillars when first hatched are black, but they go through numerous transformations until full grown. They are then a bluish green in color, 3 or 4 inches long, and as thick as a man's thumb. Each joint of the body has several knob-like tubercles and these change color from time to time, finally becoming blue, except the four next the head, which are red or yellow. Each tubercle has a whorl of short, stiff black hairs near the top. After attaining full growth the caterpillar spins a large cocoon in which it spends the winter. It attacks trees of many kinds, especially the apple, box elder, and soft maple. The natural enemies of this moth are numerous and will usually keep it in check. If not, spraying with Paris green or London purple will poison the caterpillars. The cocoons are large and easily seen, and if destroyed will keep the insects from increasing rapidly. (*Me. R. 1890, p. 121; Nebr. B. 14; S. Dak. B. 13, B. 18, B. 22.*)

Endive (*Chicorium endivia*).—A salad plant closely related to chicory. Data were published for 15 varieties planted at the New York State Station (*R. 1884, p. 285*). The next year 16 nominal varieties were grown, of which all but one appeared distinct (*R. 1885, p. 192*). A variety is recommended in *Minn. R. 1888, p. 260.*

Germination tests of the seed are reported in *N. Y. State R. 1883, p. 60; Ore. B. 2; Vt. R. 1889, p. 105.*

Ensilage.—See *Silage.*

Entomology.—The work of the stations in entomology includes the study of the life history and habits of insects, with special reference to the benefit or injury which they cause to agriculture, the identification of insects sent to the station by farmers and others, and experiments for the discovery or application of methods for the repression of injurious insects. Much useful information regarding insects has also been disseminated by the stations in compiled bulletins. An officer called an entomologist is employed at 30 stations.

Esparcet.—See *Sainfoin.*

Essex pigs.—See *Pigs, breeds.*

Ether extract.—The crude fat in feeding stuffs is sometimes called ether extract (see *Feeding farm animals*).

Eucalyptus trees.—Several species of Australian gum trees (*Eucalyptus*) have been planted in California (*R. 1878–'79, p. 75, R. 1885–'86, p. 120, R. 1888–'89, p. 48*). The blue gum (*E. globulus*) on account of its resistance to drought and marvelously rapid growth has found " universal acceptance for relieving the dreariness of treeless land-

scapes in the coast range and for fire wood, railroad ties, etc." Yet the soft spongy character of its wood renders it unsuited to meet the want in California of a wood "that will make a hoe-handle, or a wheel-spoke, or a plow-beam." It is thought, however, that its merits as a timber tree are not sufficiently appreciated. The red gum (*E. viminalis*) is next in general adaptation. Of other species the noted jarrah (*E. marginata*) of western Australia has been tried on the station grounds for a number of years and also distributed to a limited extent, and it has thus been proved beyond doubt that large areas, especially in Southern California near the coast, would be well suited to the growth of this tree. "The chief value of the jarrah lies in its extremely hard wood, which is not attacked by any known borer."

Experiment Station Record.—A publication issued in monthly parts by the Office of Experiment Stations, which contains abstracts of current publications of all the stations, of the several divisions of the U. S. Department of Agriculture, and of reports of foreign investigations in agricultural science. General information is also given regarding the stations and kindred institutions in this and other countries, and suggestions regarding methods and lines of investigation which may usefully be followed by our stations are made in articles by the editors and by distinguished experts in different specialties at home and abroad. A detailed subject and author index is published with each volume. As the condensed form of the Record makes its language necessarily somewhat technical, it is distributed only to such persons and institutions as make a special request for it after examination of a sample copy.

Experiment station.—See *Agricultural experiment stations.*

Extractor separator.—See *Butler extractor.*

Failyer and Willard milk test.—See *Milk tests.*

Fall webworm.—See *Webworm, fall.*

Farcy.—See *Glanders.*

Farm animals, feeding.—See *Feeding farm animals.*

Farm buildings.—See also *Dairy buildings* and *Silo.* The farm buildings of the stations have in many cases been intended to serve in some measure as models. Illustrated descriptions of various kinds of such buildings occur in the station literature, sometimes with detailed specifications. In *Utah B. 1* the dwelling and barn of that station are quite fully described. The barn of the North Carolina Station is described with constructional details (*R. 1888, p. 125*). A barn at the Vermont Station, briefly described in *R. 1891, p. 10,* has two features which call for particular attention, ventilation and watering. "The ventilating shafts pass from manure cellar to cupola, being 51 feet in perpendicular height; there are eighteen 8 by 20-inch shafts which open into the roof shafts and they have thus far given satisfaction. Each has openings on each floor and any part of the barn can be ventilated at will.

"Watering is done by what is known as the Buckley watering device. Fastened on a post in front of the stanchion, between each two cows, is an iron bucket holding a little over a gallon. They are all connected with a water tank containing a ball valve. Any draft of water in any bucket lowers the level and water flows into the tank to restore it." The arrangement is further stated to be much liked by the cattle.

Wis. R. 1888, p. 154, presents an improved plan for a hog-house, based upon one in use at that station. Points in the plan which are especially emphasized are, the division of each pen into a feeding and a sleeping room, insuring a clean, dry place to feed; facilities for ventilation and light; a system of yards into which the sleeping rooms open and by which they are kept clean and the hogs permitted to have exercise at will. A piggery at the Nebraska Station is described in *Neb. B. 6,* and one at the New York State Station, more briefly in *N. Y. State R. 1889, p. 66,* together with a poultry house and a set of stalls for bulls.

In *Wis. R. 1891, p. 281,* is given a full account of an elaborate sheep barn built at that station. The space in the extensive wings may be used either as one room or by movable partitions be divided into pens. Special emphasis is laid upon the arrangement of outside doors and windows, by which adequate ventilation is secured, and the building can be readily and completely changed according to weather from an open to a closed shed or the reverse. When doors and windows are closed ventilation is secured through shafts. A second story is also arranged for sheep. There is a special lambing room, and the main part of the building contains a shepherd's room, shearing and inspection room, etc. The figures include a hay-rack and a device for fastening windows which are thought to be especially well planned. Some features of the building adapted to experimental work can be changed to suit ordinary conditions.

In *N. Y. State R. 1889, p. 296,* is described a platform constructed for the storage of manure with cisterns beneath for the reception of liquids. The platform is made of stone and cement, the edges being slightly raised to prevent overflow except into the cisterns. A wind-mill is provided for pumping the liquid into a tank whence it can be had for distribution. *N. Y. Cornell B. 27* exhibits the ground plan and elevation of the "frame of a cheap, durable, and easily constructed covered yard" for the storage of manure till required for use, with explanations and directions for building.

In *Mo. B. 3* a chute or stall, with stanchion for holding heifers during the process of spaying, is fully figured and described.

Farm implements.—See *Dynamometer tests of farm implements.*

Farm manure.—See *Barnyard manure* and *Green manuring.*

Fat globules in milk.—See *Milk.* For Babcock's method of mounting and enumerating see *N. Y. State R. 1885, p. 270.*

Fat in feeding stuffs.—See *Feeding farm animals,* and *Appendix, Tables I and II.*

Feeding experiments.—See *Cattle, Cows, Horses, Milk, Pigs, and Sheep.*

Feeding farm animals.—See also *Foods.* The animal body is made up mainly of four classes of substances, water, ash or mineral matter, nitrogenous matter, and fat. Water constitutes from 40 to 60 per cent of the body and is an essential part. From 2 to 5 per cent of the weight of the body is ash. This occurs mainly in the bones. The fat varies greatly with the condition of the animal, but seldom falls below 6 per cent or rises above 30 per cent. The nitrogenous materials or protein include all of the materials containing nitrogen; all those outside this group are free from nitrogen, or non-nitrogenous. The nitrogen referred to here is the same as that mentioned in connection with fertilizers, and is the element which constitutes about four-fifths of the atmosphere. It occurs in plants and animals in various compounds grouped under the general name of protein. Lean meat, white of the egg, and casein of milk (curd) are familiar forms of protein. The albuminoids are a class of compounds included under protein. Protein is undoubtedly of first importance in the animal economy. The flesh, skin, bones, muscles, internal organs, brain, and nerves, in short all of the working machinery of the body, is composed very largely of nitrogenous substances (protein).

Principles of scientific feeding.—The proportion in which these four different classes of substances occur depends upon the age of the animal, treatment, purposes for which it is kept, etc. The substances of the body are continually breaking down and being consumed. All work, movement, breathing, digestion, etc., result in a breaking down of the tissue. To keep the animal in a healthy condition there must be a constant supply of new material. If this is lacking or insufficient, hunger and finally death result. To keep up this supply is one of the chief functions of food, but in addition to this the food maintains the heat of the body and at the same time furnishes the force or energy which enables the animal to move the muscles and do work and also to perform the functions of the body.

If in addition to repairing the waste of the system and furnishing it with heat and energy, growth is to be made, as in the case of immature animals, or milk secreted, an additional supply of food will be required. To supply food in the right proportion to meet the requirements of the animal without a waste of food nutrients, constitutes scientific feeding. It is by carefully studying the composition of feeding stuffs, the proportion in which they are digested by different animals and under different conditions, and the requirement of animals for the various food nutrients when at rest, at work, giving milk, or producing wool, mutton, beef, pork, etc., that the principles of scientific feeding have been worked out.

COMPOSITION OF FEEDING STUFFS —The food of herbivorous animals contains the same four groups of substances found in the body, viz, water, ash, nitrogenous materials, and fat; and in addition to these a class of materials called carbohydrates.

Water.—However dry a feeding stuff may appear to be, whether hay, coarse fodder, grain, or meal, it always contains a considerable amount of water, which is invisible and imperceptible to the senses, but which can be driven out by heat. This water is probably of no more benefit to the animal than water which it drinks and from which the chief supply is derived. As the amount of water in a food is a useless bulk, comparisons of different kinds of foods are usually made on a dry or water-free basis, which shows the percentage of ash and food ingredients in the dry matter.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorine, and carbonic, sulphuric and phosphoric acids, and is used largely in making bone. From the ash constituents of the food the animal body selects those which it needs and the rest are voided in the manure.

Fat, or the materials dissolved from a feeding stuff by absolute ether, includes, besides real fats, wax, the green coloring matter of plants, etc. For this reason the ether extract is usually designated crude fat. The fat of food is either stored up in the body as fat or burned to furnish heat and energy.

Carbohydrates are usually divided into two groups—nitrogen-free extract, including starch, sugar, gums, and the like, and cellulose or fiber, the essential constituent of the walls of vegetable cells. Cotton fiber and wood pulp are nearly pure cellulose. The carbohydrates form the largest part of the dry matter of all vegetable foods. They are not permanently stored up as such in the animal body, but are either stored up as fat or burned in the system to produce heat and energy.

Protein (or nitrogenous materials) constitutes the flesh-forming materials of the food. It furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, the casein and albumen of milk, etc. For these purposes protein is absolutely indispensable in the food of animals. No substances free from nitrogen can be worked over into protein or fill the place of protein. Under certain conditions it is believed protein may form fat in the body, and finally it may be burned like the carbohydrates and fat, yielding heat and energy.

The sources of heat and energy, then, are the carbohydrates of the food and the fat and protein of the food or the body, for the fat and protein in the body may be burned like those in the food. The fuel value of fat is about two and a half times that of carbohydrates and protein. The sources of fat in the body are the fat, carbohydrates, and probably the protein of the food; and the exclusive source of protein in the body is the protein in the food.

The composition of feeding stuffs is determined by chemical analysis. A large number of such analyses have been made in this country and these have been compiled and published in Bulletin No. 11 of the Office of Experiment Stations. For a summary of these analysis see *Appendix, Table I.* Such analyses usually give the percentages of water, ash, cellulose (fiber), fat, protein, and nitrogen free extract. But only a portion of each of these various ingredients in a feeding stuff is digested.

DIGESTIBILITY OF FEEDING STUFFS.—A portion of the food which is eaten is dissolved and otherwise altered by the juices of the mouth, stomach, and intestines,

taken up from the alimentary canal, and in the form of chyle passes into the blood and finally serves to nourish and sustain the body. This portion is said to be digested and assimilated and from it alone the animal is nourished. The other portion, which is not digested, passes on through the body and is excreted as manure. As the rates of digestibility are not constant for different foods and as only the digestible portion is of any nutritive use to the animal, it is essential to know in the case of each feeding stuff what part of its protein, fat, and carbohydrates, the total quantity of which is shown by analysis, is actually digested by the animal. This is determined by actual feeding trials with animals, and to secure approximately accurate figures the trials are repeated with a large number of animals and under various conditions. Many such practical trials have been made chiefly at German experiment stations. The larger number of these have been with cattle and sheep, though some have also been made with horses and swine.

Amounts of digestible nutrients in different feeding stuffs.—Combining the tables of composition of American feeding stuffs and the average coefficients of digestibility, we have the following table which shows the average amounts of digestible food materials in each of a number of common feeding stuffs.

Digestible food ingredients in 100 pounds of feeding stuffs.

	Water.	Protein.	Carbohydrates.	Fat.	Fuel value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Green fodders:					
Corn fodder*	79.3	1.45	11.78	0.38	26,210
Rye fodder	76.6	2.06	14.04	0.45	31,845
Oat fodder	62.2	2.69	22.36	1.04	50,980
Redtop (Herd's grass)	65.3	1.37	16.47	0.44	35,040
Orchard grass	73.0	1.52	11.43	0.46	26,030
Meadow fescue	69.9	1.37	14.27	0.39	30,735
Timothy	61.6	1.51	18.56	0.59	39,830
Red clover before bloom	72.0	3.70	14.90	0.52	36,790
Red clover in bloom	72.7	3.17	14.29	0.64	35,175
Red clover after bloom and in seed	68.2	2.88	15.04	0.63	36,000
Alsike clover	74.8	2.39	11.34	0.40	27,225
Cowpea	83.6	1.66	7.16	0.12	16,910
Alfalfa (lucern)	71.8	3.89	11.92	0.45	31,305
Soja bean	74.8	2.07	11.44	0.30	26,395
Corn silage	79.1	0.82	10.89	0.68	24,655
Hay and dry, coarse fodder:					
Hay from—					
Redtop (Herd's grass)	8.9	3.87	39.69	0.93	84,945
Orchard grass	9.9	4.74	38.89	1.33	86,765
Timothy (in bloom)	15.0	2.93	41.00	1.47	87,915
Timothy (soon after blooming)	14.2	2.78	41.95	1.47	89,380
Timothy (nearly ripe)	14.1	2.44	42.88	1.08	88,850
Hungarian grass	7.7	4.50	45.60	0.88	96,795
Red clover	15.3	8.06	39.07	2.14	96,695
Alsike clover	9.7	7.85	41.07	1.28	96,395
White clover	9.7	11.49	39.50	1.47	101,045
Alfalfa (lucern)	8.4	10.81	39.66	1.24	99,110
Cowpea	10.7	11.45	38.08	0.87	95,795
Corn fodder, field cured	42.2	2.17	31.98	1.07	68,035
Corn stover, field cured	40.5	1.52	25.60	0.33	51,835
Wheat straw	9.6	0.80	38.04	0.46	74,230
Rye straw	7.1	0.74	42.70	0.35	82,275
Oat straw	9.2	1.58	41.63	0.74	83,490

* Average for all varieties.

Digestible food ingredients in 100 pounds of feeding stuffs—Continued.

	Water.	Protein.	Carbohydrates.	Fat.	Fuel value.
Roots and tubers:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Potatoes	78.9	1.27	15.57	....	31,325
Red beets	88.5	1.15	8.58	....	18,100
Sugar beets	86.5	1.12	10.21	....	21,075
Mangel-wurzels	90.9	0.87	6.12	0.20	13,845
Turnips	90.5	0.63	6.68	0.20	14,441
Ruta-bagas	88.6	0.74	8.42	0.20	17,885
Carrots	88.6	0.68	8.82	0.37	19,230
Grains, seeds, and milk products:					
Corn, kernels of dent varieties	10.6	7.85	66.97	4.28	157,230
Corn, kernels of flint varieties	11.3	8.00	66.40	4.28	156,440
Barley	10.9	8.69	64.61	1.60	143,090
Oats	11.0	9.25	48.31	4.17	124,655
Corn meal	15.0	7.00	66.21	3.25	149,885
Oatmeal	7.9	11.52	52.00	5.93	143,175
Barley meal	11.9	7.36	62.36	1.96	143,480
Pea meal	10.5	17.96	57.14	0.90	137,950
Ground corn and oats, equal parts	11.9	7.39	61.20	3.74	143,365
Waste products:					
Gluten meal	9.6	24.99	49.80	4.79	159,325
Malt sprouts	10.2	18.73	43.51	1.16	120,665
Brewers' grains:					
Wet	75.7	3.93	9.50	1.34	30,635
Dry	8.2	13.71	36.95	4.53	113,345
Rye bran	11.6	6.04	38.89	1.40	89,480
Wheat bran	11.9	11.17	54.25	3.52	136,535
Wheat middlings	12.1	11.32	57.55	3.52	142,954
Wheat shorts	11.8	10.81	55.93	3.96	140,850
Cotton-seed meal	8.2	36.67	18.77	12.50	155,870
Linseed meal:					
Old process	9.2	28.22	32.90	7.10	143,630
New process	10.1	27.06	32.82	2.74	122,945
Palm-nut meal	8.3	13.62	54.13	3.12	139,190

The last item indicates the so-called "fuel value" of the food. This is measured in so-called "heat units" or calories. A calory of heat is the amount required to raise the temperature of a pound of water about 4 degrees (Fahrenheit). Thus, the fuel value of 1 pound of digestible fat is estimated to be 4,220 calories and of 1 pound of digestible protein or carbohydrates, 1,860 calories.

The meaning of the figures in this table may be explained by the following example: In 100 pounds of green corn fodder containing an average amount of water (79.3 pounds) there are contained approximately 1.45 pounds of digestible protein (materials containing nitrogen), 11.78 pounds of digestible carbohydrates (starch, sugar, fiber, etc.), and 0.38 pound of digestible fat; and these materials when burned in the body will yield 26,210 calories of heat, furnishing energy for work and maintaining the temperature of the body.

Feeding standards.—It will be remembered that the two primary functions of food are to repair the waste of the body, to promote growth in immature animals, and to furnish heat and energy. The value of the food for these purposes is represented by the digestible protein and the fuel value. The food requirements of animals differ with the purpose for which they are kept. It is plain that an ox remaining at rest in the stall requires less food than one which is worked hard every

day. This means that less protein is required to repair the tissue of the body which is broken down in work and less carbohydrates and fat to furnish energy and heat. The attempt has been made to formulate the food requirements of various kinds of animals under different conditions in what are called feeding standards. These are nothing more nor less than the average results of many carefully conducted experiments. They are not infallible formulas to be blindly followed, but simply aids to rational feeding. Exact recipes to take the place of intelligent observation on the part of the feeder are nowhere to be found. The standards worked out by Dr. Emil Wolff, an eminent German experimenter, have been widely used. They are as follows:

Wolff's feeding standards.

PER DAY AND PER 1,000 POUNDS LIVE WEIGHT.

	Digestive nutritive substances.			Fuel value.
	Protein.	Carbo-hydrates.	Fat.	
	Pounds.	*Pounds.*	*Pounds.*	*Calories.*
Oxen at rest in stall	0.7	8.0	0.15	16,815
Wool sheep:				
Coarser breeds	1.2	10.3	0.20	22,234
Finer breeds	1.5	11.4	0.25	25,049
Oxen:				
Moderately worked	1.6	11.3	0.30	25,260
Heavily worked	2.4	13.2	0.50	31,126
Horses:				
Moderately worked	1.8	11.2	0.60	26,712
Heavily worked	2.8	13.4	0.80	33,508
Milch cows	2.5	12.5	0.40	29,588
Fattening oxen:				
First period	2.5	15.0	0.50	35,660
Second period	3.0	14.8	0.70	36,062
Third period	2.7	14.8	0.60	35,082
Fattening sheep:				
First period	3.0	15.2	0.50	35,962
Second period	3.5	14.4	0.60	35,826
Fattening swine:				
First period	5.0	27.5		60,450
Second period	4.0	24.0		52,080
Third period	2.7	17.5		....

PER HEAD AND PER DAY.

	Age.	Average live weight per head.	Digestible nutritive substances.			Fuel value.
			Protein.	Carbo-hy-drates.	Fat.	
	Months.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Growing cattle	2– 3	150	0.6	2.1	0.30	6,288
	3– 6	300	1.0	4.1	0.30	10,752
	6–12	500	1.3	6.8	0.30	16,332
	12–18	700	1.4	9.1	0.28	30,712
	18–24	850	1.4	10.3	0.26	22,859
Growing sheep	5– 6	56	0.18	0.87	0.045	2,143
	6– 8	67	0.17	0.85	0.040	2,066
	8–11	75	0.16	0.85	0.037	2,035
	11–15	82	0.14	0.89	0.032	2,050
	15–20	85	0.12	0.88	0.025	1,956
Growing fat swine....	2– 3	50	0.38	1.50		3,497
	3– 5	100	0.50	2.50		5,580
	5– 6	125	0.54	2.96		6,510
	6– 8	170	0.58	3.47		7,533
	8–12	250	0.62	4.05		8,686

For an ox at rest this standard calls for 2½ pounds of digestible protein, 12½ pounds of digestible carbohydrates, and 0.4 pound of digestible fat; or, in other words, for a ration furnishing 2½ pounds of digestible protein and 29,590 calories of heat per 1,000 pounds live weight. There are other standards which differ from these slightly, and which do not give definite amounts of food nutrients to be fed, but fix the limits within which the amounts may be varied and leave the rest to the judgment of the feeder. It is claimed by some that the standards of Wolff are too low in protein and by others that they are too high. They are probably the most reliable guides which we have at present, and it may be safely assumed that in using them the feeder will not go far amiss.

Calculation of rations.—Wolff's standard for a cow of 1,000 pounds calls for 2.5 pounds of protein and 29,590 calories of heat per day. Suppose that clover hay, corn silage, corn meal, and wheat bran be taken as a basis for a ration, giving 10 pounds of hay, 20 pounds, of silage, and 10 pounds of grain, half and half. The table shows 100 pounds of average clover hay to contain 8.06 pounds of protein and to furnish 96,695 calories of heat. Ten pounds would furnish one-tenth of these amounts or 0.81 pound of protein and 9,670 calories of heat. Reckoning in this way the protein and calories for the silage, corn meal, and bran, we have the following amounts:

10 lbs. clover hay =0.81 lbs. protein and 9,670 calories.
20 lbs. corn silage=0.08 lbs. protein and 2,465 calories.
5 lbs. corn meal =0.35 lbs. protein and 7,494 calories.
5 lbs. wheat bran=0.56 lbs. protein and 6,826 calories.

Total ration..1.80 lbs. protein and 26,455 calories.

There are still needed 0.7 pound of protein and about 3,100 calories of heat to make up the amounts called for by the standard. These amounts can only be furnished in the form of a feeding stuff very rich in protein, for any other material would make the number of calories too high. Such a material is cotton-seed meal; 2 pounds of this would furnish 0.73 pound of protein and 3,117 calories of heat, making a total of 2.53 pounds of protein and 29,572 calories, which is sufficiently close to the standard. The ration per day and per 1,000 pounds live weight would

then be 10 pounds clover hay, 20 pounds corn silage, 5 pounds corn meal, 5 pounds wheat bran, and 2 pounds cotton-seed meal.

As a matter of fact the rations commonly fed to cows fall considerably short of these amounts. But the rations commonly fed are believed to be too low in protein, for in order to secure the best results from food it must be rich in protein. And this brings out the necessity not always for more grain but for more leguminous crops. It will be seen by referring to the table of feeding stuffs given above that hay from the leguminous crops—clovers, lupines, alfalfa, cowpeas, etc.—contains three or four times the quantity of digestible protein that hay from the grasses does. By growing more leguminous crops the amount of grain required is diminished, the value of the manure is enhanced, and the soil is enriched in fertility. Not only do the leguminous crops contain relatively large amounts of nitrogen, but they are able to derive the larger part of this nitrogen during their growth from the atmosphere, requiring little manuring with nitrogenous manures. They therefore enrich the soil, the ration, and the manure in nitrogen which they derive from the atmosphere without cost to the farmer, besides improving the mechanical and physical condition of the soil. (See also *Soiling.*)

VALUE OF MANURE FROM VARIOUS FOODS.—The question of the manurial value of a crop is a most important one in selecting crops to be grown and fed, especially in localities where fertilizers or manure have to be relied upon. From three-fourths to nine-tenths of the fertilizing constituents (nitrogen, phosphoric acid, and potash) of the food may be recovered in the manure if properly cared for. The proportion varies with the kind and condition of the animals fed. A number of stations take the value of the manure into account in calculating the results of feeding experiments. Comparatively few persons realize the wide difference between the value of the manure from different crops or foods. At the current prices for fertilizers in the East, Prof. Goessmann (*Mass. State R. 1891, p. 321*) calculates the fertilizing value per ton as follows: Hay \$4.75 to \$6, clover hay \$8.40 to \$9.75, alfalfa \$8.12, serradella \$9.83, soja bean \$8.66, root crops \$0.95 to \$1.15, corn meal \$7.31, wheat bran \$13.23, gluten meal \$15.77, cotton-seed meal \$23.50, etc. Assuming three-fourths to be recovered in the manure, which is a fair estimate, the manure from a ton of hay would be worth on this basis from \$3.50 to \$4.50, from a ton of clover hay from \$6.30 to \$7.30, from cotton-seed meal \$17.60, etc. The value of the manure subtracted from the cost of the feed per ton gives the net cost of the feed. These values apply of course only to localities where barnyard manure and commercial fertilizers are relied upon for keeping up the fertility of the soil. In localities where no manure is applied to the soil or where commercial fertilizers can not be profitably used as yet, the question of the manurial value of feeding stuffs is of less importance.

For experiments in feeding animals, see *Cows, Milk Cattle, Sheep, Pigs, Horses.* For feeding stuffs, see *Foods.*

Popular articles on the principles of feeding, feeding standards, etc., have been published as follows: *Del. B. 7; Ga. B. 7; Ill. College B. 1; Iowa B. 9; Me. R. 1888, p. 102; Miss. R. 1888, p. 33; N. H. B. 4; R. 1888, p. 29, N. J. B. 10; N. C. B. 64, B. 66; Pa. R. 1889, pp. 42, 50, R. 1890, pp. 19, 27; R. I. B. 3; Tex. B. 6, R. 1888, p. 69; Vt. R. 1887, pp. 105, 112; Wis. R. 1885, p. 77.*

Feeding stuffs.—See *Foods.*

Fennel.—See *Herbs.*

Fertilizers.—See also *Manure.* In this article the term fertilizer is restricted to the materials and artificial mixtures put on the market under that name for use as manure, that is, commercial fertilizers.

USE.—Although bones and certain phosphatic manures had been used to a limited extent from early times (*N. C. R. 1879, p. 149; N. Y. State B. 26, n. ser.*), it was not until 1840, when Liebig announced his theory of plant nutrition, that commercial fertilizers (especially superphosphates) attained any extended use.

The principles underlying the use of commercial fertilizers are concisely stated in four laws laid down by Liebig, as follows:

"(1) A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants in the required quantity and in the proper form. (2) With every crop a portion of these ingredients is removed. A part of this portion is added again from the inexhaustible store of the atmosphere; another part, however, is lost forever if not replaced by man. (3) The fertility of the soil remains unchanged if all the ingredients of a crop are given back to the land. Such a restitution is effected by manure. (4) The manure produced in the course of husbandry is not sufficient to maintain permanently the fertility of a farm. It lacks the constituents which are annually exported in the shape of grain, hay, milk, and live stock."

Plants contain fourteen elementary substances which are necessary to their growth: Carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur, chlorine, silicon, calcium, iron, magnesium, manganese, potassium, and sodium. Of these, all except carbon, hydrogen, and oxygen are derived almost exclusively from the soil. Nitrogen in exceptional cases may be partly drawn directly from the air (see *Green manuring* and *Leguminous plants*). Nitrogen, phosphorus, and potassium are the elements most likely to be deficient in soils or most readily exhausted by the production and removal of crops. Commercial fertilizers are prepared and used with a view to meet the deficiency of these elements; consequently the value of such fertilizers is determined by the amount, chemical combination, etc., of the nitrogen, phosphorus, and potassium they contain. The following discussion of the essential elements of fertilizers is taken from *Conn. State R. 1891, p. 21:*

"*Nitrogen* is the rarest and commercially the most valuable fertilizing element.

"Free nitrogen is indeed universally abundant in the common air, but in this form its effects in nourishing vegetation are as yet obscure.

"Organic nitrogen is the nitrogen of animal and vegetable matters, which is chemically united to carbon, hydrogen, and oxygen. Some forms of organic nitrogen, as those of blood, flesh, and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

"Ammonia and nitric acid are results of the decay of organic nitrogen in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda; 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

"*Phosphorus* is, next to nitrogen, the most costly ingredient of fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron, and aluminum, or, in case of some 'superphosphates,' in the form of free phosphoric acid.

"Soluble phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of superphosphates, which are produced by acting on 'insoluble' or 'reverted' phosphates with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil, it gradually becomes reverted phosphoric acid.

"Reverted (reduced or precipitated) phosphoric acid means, strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. 'Reverted phosphoric acid' implies phosphates that are readily assimilated by crops.

"Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant-food, and of nearly equal commercial value.

"Insoluble phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant-food. This is especially true of the crystallized green Canada apatite. Boneblack, bone ash, South Carolina rock, and Navassa phosphate when in coarse powder are commonly of little repute as fertilizers, though good results are occasionally reported from their use. When very finely pulverized (floats) they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelops it; but when the latter decays in the soil the phosphate remains in essentially the 'reverted' form. The phosphoric acid of Thomas slag and of Grand Cayman's phosphate is freely taken up by crops.

"Phosphoric acid in all the station analyses is reckoned as 'anhydrous phosphoric acid' (P_2O_5).

"*Potassium* is the constituent of fertilizers which ranks third in costliness. In plants, soils, and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

"Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of potashes and potash salts. In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride)."

The extent to which fertilizers are used in the United States is indicated by the fact that most of the Atlantic and Gulf coast states and several of the Western States have found it necessary to pass laws regulating the manufacture and sale of commercial fertilizers. Where the soil has long been under cultivation or where specialized intensive farming is engaged in, commercial manures are very generally used, since they supply in concentrated and convenient form the fertilizing elements required by special crops and soils and furnish a valuable supplement to farm manures. On the deep, rich soils of California, the prairies of the West generally, and on the black slough soils of Alabama the use of fertilizers is as a rule unnecessary (*Ala. Canebrake B. 3, B. 10, B. 11, B. 14; Ill. B. 4, B. 8, B. 11, B. 13, B. 15, B. 17, B. 20; Ohio B., vol. III, 1, 2, 6*), but it has already been found that in many cases the California soils need to have their natural resources of plant-food supplemented by concentrated fertilizers (*Cal. B. 88*), and this probably will eventually be true for the others.

Experiments at the New Jersey Station (*B. 85, R. 1891, p. 409*) suggested that the various chemicals used in commercial fertilizers may be made a means of destroying numerous insects (cutworms, wireworms, root lice, etc.) infesting the soil. It is advised "whenever possible to apply potash in the form of kainit and nitrogen in the form of nitrate of soda, and both as top-dressing." Experiments at the New York Cornell Station (*B. 33*), however, throw doubt on the efficiency of this method as applied to wireworms.

COMPOSITION.—See *Appendix, Table IV*.

HOME MIXING.—The question of home mixing of fertilizers has been studied by several stations, in some detail by the Connecticut State, New Hampshire, and New Jersey Stations. These investigations have shown that "from such raw materials as are in our markets, without the aid of milling machinery, mixtures can be and are annually made on the farm which are uniform in quality, fine and dry, and equal in all respects to the best ready-made fertilizers" (*Conn. State R. 1889, p. 101*). The special advantages of this practice, aside from economy, are a knowledge of the kind and form of plant food used, and the ability to vary the proportions at will to supply the needs of different soils and crops (*N. J. R. 1891, p. 29*).

Whether the mixing of superphosphates with nitrates results in the loss of nitrogen has been the subject of investigation at the Maine Station (*R. 1888, p. 211*). The results indicate that the loss from this source is insignificant.

INSPECTION.—Fertilizer inspection is required by law in at least twenty-six States. In some cases the Secretaries of the State Boards of Agriculture and Commissioners of Agriculture are responsible for the carrying out of the executive details of inspection, but quite often this duty devolves upon the station officers, and in almost every case the analytical work is done in the laboratories of the stations or agricultural colleges of the different States.

The laws enacted for the control of the fertilizer trade are generally of two classes, those which require an analysis (or license) fee, and those which provide for a tonnage tax. An illustration of the former as interpreted by the official inspector is afforded by the following abstract from the Connecticut law, with comments, given in *Conn. State R. 1891, p. 13.*

"(1) In case of fertilizers that retail at $10 or more per ton, the law holds the seller responsible for affixing a correct label or statement to every package or lot sold or offered, as well as for the payment of an analysis fee of $10 for each fertilizing ingredient which the fertilizer contains or is claimed to contain, unless the manufacturer or importer shall have provided labels or statements and shall have paid the fee. (Sections 1 and 3.)

"The station understands the 'fertilizing ingredients' to be those whose determination in an analysis is necessary for a valuation, viz, nitrogen, phosphoric acid, and potash. The analysis fees in case of any fertilizer will therefore be $10, $20, or $30, according as one, two, or three of these ingredients are contained or claimed to exist in the fertilizer.

"(2) The law also requires, in case of any fertilizer selling at $10 or more per ton, that a sealed sample shall be deposited with the director of the station by the manufacturer or importer, and that a certified statement of composition, etc., shall be filed with him.

"A statement of the per cents of nitrogen, phosphoric acid (P_2O_5) and potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

"In all cases the per cent of nitrogen must be stated. Ammonia may also be given when actually present in ammonia salts, and 'ammonia equivalent to nitrogen' may likewise be stated.

"The per cent of soluble and reverted phosphoric acid may be given separately or together, and the term 'available' may be used in addition to, but not instead of, soluble and reverted.

"The percentage of insoluble phosphoric acid may be stated or omitted.

"In case of bone, fish, tankage, dried meat, dried blood, etc., the chemical composition may take account of the two ingredients, nitrogen and phosphoric acid.

"For potash salts give always the per cent of potash (potassium oxide); that of sulphate of potash or muriate of potash may also be stated.

"The chemical composition of other fertilizers may be given as found in the station reports.

"(3) It is also provided that every person in the State, who sells any commercial fertilizer of whatever kind or price shall annually report certain facts to the director of the experiment station, and on demand of the latter shall deliver a sample for analysis. (Section 4.)

"(4) All 'chemicals' that are applied to land, such as muriate of potash, kainit, sulphate of potash and magnesia, sulphate of lime (gypsum or land plaster), sulphate of ammonia, nitrate of potash, nitrate of soda, etc., are considered to come under the law as 'commercial fertilizers.' Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the station, and see that the analysis fees are duly paid, in order that the director may be able to discharge his duty as prescribed in section 9 of the act.

"It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and

whether fertilizers are what they purport to be. With this object in view the law provides, in section 9, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part, the State itself paying in part by maintaining the experiment station."

The second class of fertilizer laws is illustrated by the following digest of the North Carolina law (*N. C. B. 86b*).

"No manipulated guanos, superphosphates, commercial fertilizers, or other fertilizing material shall be sold or offered for sale unless a tonnage charge of 25 cents per ton has been paid. Each barrel, package, or bag shall have attached a tag representing this fact, which tag shall be issued by the commissioner of agriculture according to regulations prescribed by the department of agriculture. The department of agriculture has power at all times to have samples collected of any fertilizer or fertilizing material on sale, which must be taken from at least 10 per cent of the lot selected. These samples are taken from the goods in the hands of dealers after they are shipped from the manufacturers and accordingly represent the true grade of fertilizers offered for sale.

"Every package of fertilizer offered for sale must have thereon a plainly printed label, a copy of which must be filed with the commissioner of agriculture, together with a true sample of the fertilizer which it is proposed to sell, at or before the shipment of such fertilizer into the State, and which label must be uniformly used and not changed during the year. This label must set forth name, location, and trade mark of the manufacturer, also the chemical composition of the contents and real percentage of the ordinary ingredients, together with date of analyzation, and that all charges have been paid. There must be no variation in the guaranteed percentages, but the bags must be branded with the exact chemical composition of the contents.

"It is a misdemeanor, punishable by a fine of ten dollars for each bag, for an agent or dealer to offer for sale any such fertilizer or fertilizing materials not properly tagged, or a consumer to remove it, or railroad agent to deliver it. Goods kept over from last season must be tagged to represent this fact, and all dealers are required to report the amount on hand at the close of the fiscal year on November 30. No fertilizer can be sold with a content of less than 8 per cent of available phosphoric acid, 2 per cent of ammonia, and 1 per cent of potash. The following articles are exempt: Land plaster, agricultural lime, oyster-shell lime, marl, and cotton-seed meal when not sold as a fertilizer; also materials in bulk when sent to manufacturers for mixing in fertilizers.

"Any fertilizer that is spurious and does not contain ingredients as represented by the label, is liable to seizure, and after being established on trial, its value is recovable by the board of agriculture. Any person who offers for sale fertilizers or fertilizing material without having attached thereto labels as provided by law, is liable to a fine of ten dollars for each separate package, one half, less the cost, going to the party suing, and the remainder to the department; and if such fertilizer is condemned, the department makes analysis of the same, and has printed labels giving the true chemical ingredients of the same put on each package, and fixes the commercial value at which it may be sold. The department of agriculture can require agents of railroads and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them. The experiment station analyzes samples taken by the official inspector, and publishes the results when deemed needful."

Although the laws of the different States vary in details the essential features of the two classes as illustrated above remain the same.

The following table gives in brief the requirements of the laws in the different States:

State.	Requirements.
Alabama	License fee of $1 for each brand and tax of 50 cents per ton for tags.
Arkansas	Analysis fee of $15 for each brand.
Delaware	Analysis fee of $30 to $40.
Georgia	Tax of 50 cents per ton for tags.
Indiana	Analysis fee of $2 and $1 per 100 for tags.
Kentucky	Analysis fee of $15 and $1 per hundred for tags.
Louisiana	Tax of 50 cents per ton for tags.
Maine	License fee of $50 for first brand, and $15 for each additional brand.
Maryland	License fee of $5 for the first 100 tons or part thereof, and $3 for each additional 100 tons or part thereof.
Massachusetts	Analysis fee of $5 for each essential element guaranteed.
Michigan	License fee of $20 per brand.
Mississippi	Analysis fee of $20 per brand.
New Hampshire	License fee of $50 per brand.
New Jersey	Analysis fee of $15.
New York	No analysis fee or tax.
Ohio	License fee of $50 per brand.
Pennsylvania	License fee of $10 for 100 tons, $20 for 100-500 tons, and $30 for 500 tons or more.
Rhode Island	Analysis fee of $6 for each essential element guaranteed.
South Carolina	Tax of 25 cents per ton for tags.
Tennessee	Tax of 50 cents per ton.
Vermont	License fee of $100 for all; one license covers all brands of each manufacturer.
West Virginia	Analysis fee of $10 for each essential element guaranteed. Tags, which must be attached to each package, are furnished by the inspector at 50 cents per hundred.

Violations of the provisions of the different laws are punishable in different cases by fines varying from $10 to $500, or imprisonment from two to five years.

It will be seen from the table that in every case except one (New York) the expenses of inspection are provided for by a fee or tax required of the manufacturers or dealers. In some States this tax or fee is fixed at an amount barely sufficient to meet the expenses of inspection, while in others it is so high as to yield a large revenue. In some cases this revenue is used in scientific investigations; in others it is turned into the State treasuries.

(*Ala. College R. 1888, p. 7; Ark. B. 10, R. 1889, p. 13; Conn. Storrs R. 1891, p. 13; Ind. B. 22; Ky. B. 14; La. B. 12, 2d ser.; Me. R. 1886, p. 21; Md. Special B., Oct., 1890; Mich. B. 52; N. J. R. 1888, p. 225; N. Y. State R. 1888, p. 22, R. 1890, p. 72; N. C. B. 86b; Pa. B. 7; R. I. B. 16; S. C. B. 3; Tenn. R. 1883–'84, p. 137; Vt. R. 1890, p. 25; W. Va. B. 18.*)

The perfecting of methods of examination of fertilizers naturally occupies a considerable part of the time of the stations. The results of this work appear annually in the Proceedings of the Association of Official Agricultural Chemists, published by the U. S. Department of Agriculture.

It has been proposed to distinguish fertilizers containing readily available organic nitrogen (in the form of fish, blood, bone, cotton-seed meal, etc.) from those containing nitrogen in the form of difficultly soluble substances (horn, leather, wool waste, etc.) by digestion with an acid pepsin solution. This method has been thoroughly investigated at the Connecticut State Station (*R. 1885, p. 115, R. 1886, p. 80*). The principal results are summarized as follows: "Seventy-five per cent or more of the nitrogen of dried blood, cotton-seed, castor pomace, and maize refuse, under the

conditions of the experiment, was soluble in pepsin solution. Fifty-two per cent or more of the nitrogen of fish, tankage, horse meat, etc., and of bone was soluble. In no case was more than 36 per cent of nitrogen of leather (roasted, steamed, or extracted with benzine) soluble, and the nitrogen of horn shavings, horn dust, ground horn and hoof, cave guano, felt, and wool waste, was considerably less soluble than that of leather."

These results have been substantially confirmed at the Maine Station (*R. 1889, p. 30*), the conclusion being reached that a solubility of less than 50 per cent of nitrogen originally present "is to be regarded as indicating the presence of organic material of a lower grade than dried blood, dried flesh, and dried fish." The method has been applied in the practical work of fertilizer inspection at the Maine and Vermont Stations.

VALUATION.—In many of the stations the practice of computing the commercial value of fertilizers is followed. The nature and uses of this valuation are thus explained in the *Conn. State R. 1891, pp. 22, 24, 25*:

"The valuation of a fertilizer, as practiced at this station, consists in calculating the retail trade value or cash cost (in raw material of good quality) of an amount of nitrogen, phosphoric acid, and potash equal to that contained in 1 ton of the fertilizer.

"Plaster, lime, stable manure, and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade value on the three substances, nitrogen, phosphoric acid, and potash, which are comparatively costly and steady in price. The trade value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

"The consumer in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade value of the above-named ingredients a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use. * * *

"The uses of the 'valuation' are two-fold:

"(1) To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is 20 to 25 per cent higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

"(2) Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

"But the valuation is not to be too literally construed, for analysis cannot decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

"For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

"For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

"Experience leads to the conclusion that the trade-values adopted at the beginning of a year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

"The *agricultural value* of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad,

general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner."

For valuation of bones and tankage see *Bones*.

EXPERIMENTS.—Many of the stations, coöperating with farmers, have carried out experiments with fertilizers for the purpose of ascertaining the local peculiarities and needs of the soils of their respective States. The following plan recommended by the Office of Experiment Stations (*Circular No. 7*) has been followed in all essential details in these experiments:

Field.—Length, 213 feet 4 inches; width, 204 feet; area, 43,520 square feet. (One acre is 43,560 square feet.)

Plats.—Length, 204 feet; width, 10 feet 8 inches; area, 2,176 square feet. (One-twentieth of an acre is 2,178 square feet.)

Strips between and outside the experimental plats.—Length, 204 feet; width, 3 feet 4 inches.

The kinds and amounts of fertilizing materials recommended to be used on these plats are given in the following table:

Fertilizers to be used on experimental plats.

Fertilizing material.			Valuable ingredients.	
Kinds.	Amount per plat.	Amount per acre.	Kinds.	Amount per acre.
	Pounds.	*Pounds.*		*Pounds.*
Nitrate of soda	8	160	Nitrogen	26
Dissolved bone-black	16	320	Phosphoric acid	51
Muriate of potash	8	160	Potash	80
Nitrate of soda Dissolved bone-black	8 16	160 320	Nitrogen Phosphoric acid	26 51
Nitrate of soda Muriate of potash	8 8	160 160	Nitrogen Potash	26 80
Dissolved bone-black Muriate of potash	16 8	320 160	Phosphoric acid Potash	51 80
Nitrate of soda Dissolved bone-black Muriate of potash	8 16 8	160 320 160	Nitrogen Phosphoric acid Potash	26 51 80
Plaster	8	160		

The action of farm manures, lime, and other fertilizing materials may also be tested.

The directions for the experimenter's use are in brief as follows:

"(1) Have your plans all made and everything ready before you start. Remember that worn-out soil for the soil tests, uniform soil for all, plats long and narrow and accurately measured and staked out, and right application of the fertilizers are essential to the best success.

"(2) Select a fair average portion of the field to be tested and lay it out as accurately as you can. Leave an unmanured strip at least 3 feet wide between each two plats, to prevent the roots of the plants from feeding on their neighbor's fertilizers.

"(3) Designate each plat by a number, as suggested in the diagrams, and corresponding to the number of the fertilizer.

"(4) Distribute each fertilizer evenly over its plat, and do not let it get outside, and mix well with the soil, especially when it is put near the seed.

"(5) Be as systematic and as accurate as you can, not only in starting the experiments, but in carrying them out, harvesting and measuring the produce, and noting the results."

While the results of most of these coöperative experiments have of course been of local value only, in a few instances facts have been brought out which are applicable to comparatively large areas of soil, and which are, therefore, of more general interest.

Such experiments have indicated that there are large areas of soil in Kentucky, New Hampshire, and Massachusetts which are deficient in potash; that phosphoric acid is needed on the upland soils of Alabama; and that on much of the soil of the West and on the "black slough" canebrake soils of Alabama the use of fertilizers is unprofitable.

Taken altogether, these experiments show in general that—

"Soils vary widely in their capacities for supplying crops with food, and consequently in their demand for fertilizers.

"Some soils will give good returns for manuring; others, without previous amendment, by draining, irrigation, tillage, or use of lime, marl, etc., will not.

"Farmers can not afford to use commercial fertilizers at random, and it is time they understood the reason why.

"The right materials in the right places bring large profits. Artificial fertilizers rightly used must prove among the most potent means for the restoration of our agriculture.

"The only way to find what a soil wants is to study it by careful observation and experiments." (Atwater.)

(*Ala. Canebrake B. 3, B. 10, B. 11, B. 14; Ala. College B. 12, n. ser., B. 23, n. ser., B. 34, n. ser.; Cal. B. 88; Conn. State R. 1889, p. 101, R. 1891, pp. 13, 22; Conn. Storrs R. 1891, p. 173; Del. B. 11; Ga. B. 15; Ill. B. 4, B. 8, B. 11, B. 15, B. 17, B. 20; Ky. B. 26; Me. R. 1888, pp. 69, 211, R. 1890, p. 79; Mass. Hatch B. 9, B. 14; N. H. B. 6, B. 10, B. 12; N. J. B. 85, R. 1891, pp. 29, 409; N. Y. State B. 26, n. ser.; N. C. B. 65, B. 71, R. 1879, p. 149; Ohio B. vol. III, 1, 2, 6; R. I. R. 1891, p. 35.*)

Fescue.—See *Grasses.*

Fibrin in milk.—See *Creaming of milk.*

Fig.—The fig has been studied at several stations with reference to varieties and method of culture. Experimental plantations are noted in *Ala. College R. 1888, p. 5; Cal. R. 1888–'89, pp. 87, 137, 186; La. B. 22, B. 8, 2d ser.; N. C. B. 72; R. I. B. 7; Tenn. B. vol. III, 5; R. 1888, p. 12, Tex. B. 8.*

At the California Stations (*B. 96*) the fig was regarded as promising to become one of the most important fruit trees of the State, and it was therefore decided to stock the stations in different parts of the State with every distinct variety to observe their growth, hardiness, and characters. About 50 varieties were obtained and planted at the several stations, and the first results on the different soils and under the different climatic conditions, especially with reference to hardiness, are reported. Some varieties suffered from frost even at the Southern California Station, but success with some appears to have been indicated at all the stations, though a careful choice of locality seemed requisite at the Southern Coast Range Station. In *Cal. B. 98* it is suggested that the search for a drying fig which shall enable the State to produce an article comparable with the Smyrna fig of commerce has obscured efforts to add to the list of desirable table varieties, an unfortunate tendency, considering that a great portion of the State with the proper varieties can grow figs, while not all parts are suited to drying figs. Several newly introduced table varieties are offered for distribution. Special attention has also been given to fig culture at the North Carolina Station, as reported chiefly in *B. 74.* A large part of the State is said to be adapted to fig culture, and in every part a supply for home use can be had by winter protection. Instructions are given for propagation by cuttings and layers and in greenhouses by single eyes. In frosty regions it is recommended to grow the fig in the form of a

spreading bush, in order that the branches may be laid down and covered in winter. The plan for covering is to gather the branches into four bundles, fasten these down with a forked peg, and cover with earth; in very cold regions also with straw or leaves. It is thought that the cultivation of the fig for drying, canning, and preserving might be indefinitely extended in the State. The distribution of 1,000 young fig trees is noted in *N. C. R. 1891, p. 13.*

Filberts (*Corylus avellana* var.).—Experimental plantations are reported in *Cal. R. 1888–'89, pp. 110, 196; La. B. 22, B. 8, 2d ser.; R. I. B. 7.* At the California Station 11 varieties were planted. Some portions of that State seemed too dry for their success. An analysis of filberts from a foreign source is quoted in *Pa. B. 16.*

Fir trees (*Abies* spp.).—The balsam fir (*A. balsamea*) [also called Balsam spruce and Balm-of-Gilead fir] is noted in *Minn. B. 24* as a "slender tree of much beauty in moist localities and rich soil, but not nearly so valuable for screens or ornamental planting generally as the white or Norway spruce," and to be "used very sparingly in dry localities." The same as planted at the South Dakota Station is noted in *R. 1888, p. 26, B. 12,* and is mentioned in *B. 23* as a tree which may be cultivated in the southern part of the State. The Western silver fir (*A. concolor*) was found quite hardy at the Minnesota Station (*B. 24*), but of too slow growth to be popular. At the Kansas Station (*B. 10*) it did not seem at home in the soil and climate. The Douglas fir or spruce (also called Oregon pine), described in *Kans. B. 10,* did not permit recommendation for planting, but warranted further trial. The Siberian silver fir (*A. pichta* or *sibirica*) seemed at the same station to be a failure for that locality.

Fish.—For composition of dried fish used as a fertilizer see *Appendix, Table IV.*

Flax (*Linum* spp.).—An annual plant, with slender stems about 2 feet tall and flowers nearly blue. Its elongated bast cells form the fiber used in the manufacture of linen, laces, etc. The seeds, known as linseed and flaxseed, are used in medicine. They also yield linseed oil or may be ground into linseed meal for feeding purposes. The residue after the extraction of the oil is pressed into a cake, which is also used as a feeding stuff. Since the introduction of cheap cotton fabrics and the abandonment of hand-weaving, flax has been grown in this country chiefly for its seed. In recent years, however, the desire to diversify agricultural industries has led to renewed attempts to grow flax for its fiber. The U. S. Department of Agriculture has taken a leading part in this movement. The experiment stations and private individuals have also made experiments in this line. The investigations are yet in their preliminary stage. Much information regarding flax culture has been distributed and experiments have indicated that good crops of fine fiber may be grown in certain localities, especially in California and Minnesota.

Minn. B. 13 contains a useful summary of information, chiefly from foreign sources, regarding the culture of flax. The species known as *Linum usitatissimum* is the most valuable. Other species or varieties are: Perennial flax (*Linum perenne*), of little economic value; winter flax, a somewhat uncertain variety, adapted only to regions having a peculiar climate; *Linum crepitans,* so called from the crackling sound accompanying the explosive opening of its seed capsules, producing abundant seed but relatively small fiber; and white-flowering American flax (*Linum americanum album*), a tall plant with white flowers, which produces a large crop of good fiber, but which deteriorates so rapidly that the seed must be renewed at least every second year.

New Zealand flax (*Phormium tenax*) is a perennial plant very different in appearance from the real flax. It has a strong fiber, used for making cordage, paper, etc. Strips of the leaves may be used for many purposes by the farmer and gardener. The plant does not thrive in a very hot and dry climate (*Cal. R. 1890, p. 190*).

For its best development flax requires "a moist, moderately warm climate, free from late frosts in spring, with numerous rains during the growing season." The land should be comparatively level and the soil soft, light, and free from weeds. A deep layer of humus over a relatively moist subsoil is very desirable. The land

must be thoroughly drained. The seed bed should be clean, deep, and fine. Deep plowing in the fall is important for this crop. The more weeds the less flax. Flax may follow almost any crop that has been well manured, except turnips or beets, but should not be grown continuously on the same land. Great care should be exercised in the selection of seed. "A good seed should be moderately thick, short, and equal; should have a glossy yellowish-brown or greenish-yellow color; should be smooth and soft to the touch, and should taste sweetish." Carefully conducted experiments have indicated that strong plants are produced from seeds roasted at a temperature of from 112° to 122° F. Experience in Europe has shown that really good seed can be produced only on strong soil and with the most careful attention to cultivation and harvesting. Seed produced in certain regions of Russia is very highly esteemed. If grown for fiber, from 1½ to 2 bushels of seed per acre should be used; if for fiber and seed, 1 bushel; if for seed alone, ¾ bushel. The time of sowing will depend on climatic conditions, but should be relatively early. "Whoever wants a good crop of flax must tire his harrow." The seeding should ordinarily be broadcast, preferably with a machine. When the crop is grown for seed only, the drill may be used. Follow seeding with a light harrow and then with a roller. If the plants remain small and of unequal length, fine wood ashes or gypsum may be applied. Careful and thorough weeding must be done when the plants are 7 or 8 inches high. Among the most troublesome weeds in flax fields are the wild mustard, pigeon grass, and wild morning glory. The dodder may also become a great pest. The most dangerous fungous disease affecting flax is a rust (*Melamspora lini*). A diseased condition of this plant is also caused by growing it continuously on the same land.

An illustrated description of the structure of the stem of the flax plant is given in *Minn. B. 13.*

Tests of varieties.—Brief accounts are given in *Cal. B. 90; Mass. Hatch B. 18; Miss. R. 1891; Nebr. B. 19; N. Y. State R. 1890, p. 358.*

Composition.—The amount of soil ingredients withdrawn from 1 acre by flax is stated in *Cal. B. 94* to be as follows:

	Crop.	Potash.	Phosphoric acid.	Nitrogen.	Lime.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Straw	1,800	23.04	7.87	18.00	13.63
Seed	1,724	20.60	32.00	56.24	5.80
Fiber	600	0.13	0.72	....	3.27
Whole plant	4,124	43.77	40.59	....	22.70

Flaxseed.—A feeding trial with flaxseed for cows is reported in *Iowa B. 16.*

Flea beetles.—Among insects called by this name is the wavy-striped flea beetle (*Phyllotreta vittata*), which infests cabbage, turnip, mustard, radish, potato, strawberry, and other plants, doing them serious injury, especially the young plants. It is about one-tenth of an inch long and may be easily distinguished from other species by its shining black color and two wavy yellow lines along its sides. All flea beetles when alarmed escape by jumping, whence their name. Paris green with flour, lime, ashes, powdered tobacco, are all recommended as useful if used on plants when wet with dew. Kerosene emulsion, tobacco decoction, pyrethrum (dry or emulsion), or the arsenite sprays, are all good, either in killing or repelling the flea beetles. There are several other genera and species of flea beetles, but the same treatment must be used for all. Their jumping habit will identify them as flea beetles. (*Del. B. 12; Fla B. 9; Ind. B. 33; Iowa B. 15; Ky. R. 1889, p. 23; Nebr. B. 16; N. C. B. 78; Ohio B. vol. IV, 2; Ore. B. 5; W. Va. R. 1890, p. 147.*)

Floats.—See *Phosphates.*

Flocculation of soils.—See *Clay.*

Florida phosphates.—See *Phosphates.*

Florida Station, Lake City.—Organized in 1888 as a department of the Florida Agricultural and Mechanical College, under the act of Congress of March 2, 1887. Substations have been established at Fort Myers and De Funiak Springs. The staff consists of the president of the college, director, horticulturist, botanist and entomologist, chemist, veterinarian, and two foremen of substations. The principal lines of work are chemistry, field experiments with crops, and horticulture. Up to January 1, 1893, the station had published 3 annual reports and 19 bulletins. Revenue in 1892, $15,061.

Flour corn, Brazilian.—See *Brazilian flour corn.*

Fodder corn.—See *Corn.* For feeding trials with fodder corn see *Silage.* For composition see *Appendix, Tables I and II.*

Fodders.—See *Foods.*

Foods.—The terms foods, feeds, fodders, feeding stuffs, etc., are used to mean all natural and artificial products which are used as food for animals. The term foods is also applied to materials used as food by man (see *Food, human*). The ingredients or constituents of foods are called nutrients. The composition (food and fertilizing ingredients) of feeding stuffs and the functions of the various nutrients, is explained above under *Feeding farm animals.* The average composition of a large number of feeding stuffs, with reference to both food and fertilizing constituents is given in *Appendix, Tables I and II,* and a compilation of American analyses of feeding stuffs is published in *B. 11* of the Office of Experiment Stations, U. S. Department of Agriculture.

FOODS, HUMAN.—Investigations on the composition of human foods, the dietaries of persons of various callings and circumstances, the food requirements of persons engaged in different kinds of work, and the forms in which these nutrients can be most economically supplied, have been made by the Connecticut Storrs Station (*B. 7, B. 8, R. 1891, pp. 41, 161*).

The following table (taken from *B. 7*) gives the amounts of nutrients contained in a number of actual dietaries in the United States and Canada, as compared with the standard dietaries proposed by scientists who have investigated the subject:

Standard vs. actual daily dietaries for people of different classes.

[100 grams=3.5 ounces or 0.22 pounds. 1 ounce=28.35 grams. 1 pound=453.6 grams.]

	Nutrients.				Potential energy of nutrients.
	Protein.	Fat.	Carbohydrates.	Total.	
Standards for daily dietaries.					
Voit *et al:*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Children, 1 to 2 years (German)	28	37	75	140	765
Children, 2 to 6 years (German)	55	40	200	295	1,420
Children, 6 to 15 years (German)	75	43	325	443	2,040
Aged woman (German)	80	50	260	390	1,860
Aged man (German)	100	68	350	518	2,475
Woman at moderate work (German)	92	44	400	536	2,425
Man at moderate work (German)	118	56	500	674	3,055
Man at hard work (German)	145	100	450	695	3,370
Playfair:					
Man with moderate exercise (English)	119	51	531	701	3,140
Active laborer (English)	156	71	568	795	3,630
Laborer at hard work (English)	185	71	568	824	3,750
Atwater:					
Woman with light exercise (American)	80	80	300	460	2,300
Man with light exercise (American)	100	100	360	560	2,815
Man at moderate work (American)	125	125	450	700	3,520
Man at hard work (American)	150	150	500	800	4,060
Actual dietaries in United States and Canada.					
French-Canadian working people in Canada	109	109	527	745	3,620
French-Canadians, factory operatives, in Massachusetts	118	204	549	871	4,630
Other factory operatives, mechanics, etc., in Massachusetts	127	186	531	844	4,430
Glass-blowers, East Cambridge, Mass	95	132	481	708	3,590
Factory operatives, boarding house, Mass	114	150	522	786	4,000
Well-to-do private family, Connecticut:					
Food purchased	129	183	467	779	4,145
Food eaten	128	177	466	771	4,080
College students from Northern and Eastern States, boarding club, two dietaries, same club:					
Food purchased	161	204	680	1,045	5,345
Food eaten	138	184	622	944	4,825
Food purchased	115	163	460	738	3,875
Food eaten	104	136	421	661	3,415
College foot ball team, food eaten	181	292	557	1,030	5,740
Mechanics (machinists), Connecticut	105	147	399	651	3,435
Machinist, Boston, Mass	182	254	617	1,053	5,640
Teamsters, marble workers, etc., at hard work, Massachusetts	254	363	826	1,443	7,805
Brickmakers, Massachusetts	180	365	1,150	1,695	8,850
U. S. Army ration	120	161	454	735	3,850
U. S. Navy ration	143	184	520	847	5,000

The composition of many materials used for human food is given in the *Appendix, Tables I, II, and III.* The results of the investigations by Prof. Atwater at the Connecticut Storrs Station in general indicate that Americans of different occupations have a liberal and even wasteful diet; that many people in this country consume excessive quantities of food, much of which is needlessly expensive; and that too much carbohydrates and fat are produced and consumed, and too little protein.

FOODS FOR ANIMALS, DIGESTIBILITY.—As explained under *Feeding farm animals*, only a portion of the protein, fat, and carbohydrates eaten are digested and made use of by the animal, and the proportions digested vary with different foods. Thus, while less than one-fourth of the protein in wheat or rye straw is digested, from one-half to two-thirds of the protein in hay, and considerably over three-fourths of that in grain feeds is digested. Besides the method mentioned above of determining the rates of digestibility by digestion experiments with animals (the "natural" method), an artificial method has been worked out, which, however, is used only for the protein (nitrogenous matters). This depends upon dissolving from a sample of feeding stuff by artificial reagents approximately the same proportion of the nitrogenous materials as would be extracted by the animal in natural digestion. The reagents used are made from the stomachs of animals. The subject of artificial digestion has been discussed, and results of tests reported as follows: *Conn. State R. 1885, p. 115, R. 1886, p. 80; Me. R. 1887, p. 127, R. 1888, pp. 90, 211, R. 1889, p. 30; N. Y. State B. 5, n. ser., R. 1885, p. 312, R. 1886, p. 337, R. 1888, p. 304.*

The subject of digestibility in general, experiments by the natural method, etc., have been discussed and reported as follows:

Colo. B. 8; Conn. Storrs B. 7; Ga. B. 7; Ill. B. 5; Me. B. 26, R. 1885–'86, p. 59, R. 1887, p. 77, R. 1888, p. 91, R. 1889, p. 53, R. 1890, p. 67; N. Y. State B. 37, B. 85, R. 1884, p. 26, R. 1888, pp. 270, 304, R. 1889, p. 95; N. C. B. 64, B. 80c; Ore. B. 6; Pa. B. 9, B. 15, R. 1888, pp. 47, 77, R. 1889, pp. 67, 113, R. 1890, p. 45; R. I. B. 3; S. C. R. 1889, p. 122; Tex. B. 13, B. 15; Vt. R. 1887, p. 84; Wis. R. 1884, p. 67, R. 1889, p. 69, B. 3.

The digestion experiments (both natural and artificial) by the stations in this country are classified as follows:

Alfalfa: *Colo. B 8* (steers); *N. Y. State R. 1889, p. 130* (cows).

Alfalfa hay: *N. Y. State R. 1889, p. 131* (cows).

Beans: *N. Y. State R. 1885, p. 315* (artificial).

Buttercup: *Me. R. 1888, p. 91* (sheep).

Clover, alsike: *Me. R. 1888, p. 91* (sheep). White clover: *Me. R. 1888, p. 91* (sheep). Green fodder: *Pa. R. 1888, p. 87* (steers). Clover hay: *N. Y. State R. 1885, p. 315* (artificial), *R. 1888, p. 305* (natural and artificial); *Me. R. 1887, pp. 72, 81* (sheep); *Wis. R. 1884, p. 76* (sheep).

Corn-and-cob meal: *Me. R. 1886, p. 59* (pig).

Corn fodder: *Wis. R. 1888, p. 56* (cows), *R. 1889, p. 69* (cows); *Pa. R. 1888, p. 91* (steers), *B. 9* (steers), *R. 1889, p. 67* (sheep), *p. 113* (steers); *R. 1890, p. 45* (sheep and steers); *N. Y. State B. 85, R. 1884, p. 26* (cows); *R. 1885, p. 315* (artificial); *R. 1888, p. 304* (natural and artificial); *Tex. B. 15* (cattle).

Corn meal: *Me. R. 1886, p. 59* (pig); *N. Y. State R. 1885, p. 315* (artificial), *B. 5, n. ser.* (artificial), *R. 1888, p. 304* (natural and artificial).

Corn silage: *Ore. B. 6; Pa. B. 9* (steers), *R. 1890, p. 45* (sheep and steers); *N. Y. State B. 37, B, 85, R. 1884, p. 26* (cows), *R. 1885, p. 315* (artificial); *Wis. R. 1888, p. 56* (cows), *R. 1889, p. 69* (cows).

Corn, whole: *Me. R. 1886, p. 59* (pig).

Cotton hulls: *N. C. B. 80c* (cow); *Tex. B. 15* (cattle).

Cotton-seed meal: *N. Y. State R. 1885, p. 315* (artificial); *Wis. R. 1884, p. 67* (sheep).

Cotton-seed meal and hulls: *N. C. B. 80c* (cows).

Germ feed: *N. Y. State R. 1885, p. 315* (artificial).

Gluten meal: *N. Y. State R. 1885, p. 315* (artificial).

Grasses, blue joint: *Me. R. 1888, p. 91* (sheep); orchard, *Me. R. 1888, p. 91* (sheep); *N. Y. State R. 1888, p. 304* (natural and artificial); pasture, *Pa. R. 1889, p. 67* (steers); timothy, *Me. R. 1886, p. 56* (sheep), *R. 1887, pp. 80, 133* (sheep and artificial), *R. 1888, p. 91* (sheep); timothy hay, *Me. R. 1887, pp. 72, 81* (sheep); *N. Y. State R. 1888, p. 305* (natural and artificial); wild oat, *Me. R. 1888, p. 91* (sheep); witch grass, *Me. R. 1888, p. 91* (sheep); green and dry grass, *Pa. R. 1888, p. 64* (cows).

Hay, mixed: *N. Y. State R. 1884, p. 26* (cows), *R. 1885, p. 315* (artificial), *R. 1889, p. 130* (cow).

Hay, clover, and timothy: *Pa. R. 1890, p. 45* (steers).

Linseed meal, old and new process: *N. Y. State R. 1885, p. 315* (artificial).

Malt sprouts: *Wis. R. 1884, p. 67* (sheep).

Oat straw: *Me. R. 1887, p. 75* (sheep); *N. Y. State R. 1888, p. 305* (artificial).

Pea meal: *Me. R. 1889, p. 66* (sheep); *N. Y. State R. 1885, p. 315* (artificial).

Potatoes, raw: *Me. R. 1887, p. 79* (sheep); *N. Y. State R. 1884, p. 26* (cows).

Potatoes, boiled: *Me. R. 1887, p. 79* (sheep).

Rye fodder: *Pa. R. 1888, p. 81* (steers).

Ship stuff: *N. Y. State R. 1885, p. 315* (artificial).

Soja bean fodder: *N. Y. State R. 1885, p. 315* (artificial); *R. 1888, p. 304* (natural and artificial).

Sorghum: *Pa. R. 1889, p. 91* (sheep); *Tex. B. 13* (cows).

Starch refuse: *N. Y. State R. 1885, p. 315* (artificial).

Wheat: *N. Y. State R. 1885, p. 315* (artificial); *R. 1888, p. 306* (artificial).

Wheat bran: *Me. R. 1889, p. 64* (sheep); *R. 1890, p. 61* (sheep) *N. Y. R. 1885, p. 315* (artificial); *R. 1888, p. 306* (artificial).

Wheat middlings: *Me. R. 1889, p. 61* (sheep); *R. 1891, p. 38* (sheep).

White weed: *Me. R. 1888, p. 91* (sheep).

Mixed rations: *N. H. B. 11* (pigs); *N. Y. State R. 1889, p. 130* (cows and steers).

FOODS FOR ANIMALS, VALUATION.—An attempt has been made to calculate the commercial value of feeding stuffs on the basis of their composition, using definite prices per pound of protein, fat, and carbohydrates This is similar to the method of valuing commercial fertilizers (see *Fertilizers*), and assumes that each pound of digestible protein, fat, and carbohydrates has a value. The prices of protein, fat, and carbohydrates are derived in much the same way as those for nitrogen, phosphoric acid, and potash in the case of fertilizer valuation. They are calculated from the average market prices of a large number of feeding materials, usually grain and commercial feeds, taking the composition of these materials into account. Several stations have at different times calculated the average cost of nutrients per pound. These very naturally vary in different localities and at different times, as they are based upon the market prices of feeding stuffs which are subject to fluctuation. The prices found for total protein per pound have ranged from 1 to 2.5 cents, for fat from 2.5 to 4.45 cents, and for carbohydrates from 0.5 to 1 cent. In applying these values to a feeding stuff the number of pounds of protein, fat, and carbohydrates in a ton of the feed are multiplied by the prices of protein, fat, and carbohydrates, respectively, and the sum compared with the market price. The object in computing valuations is to secure a basis for comparison of the cost of food nutrients in different feeding stuffs to aid in the selection of feeding stuffs most economical for the locality. An example will illustrate. The New York State Station (*B. 31, n. ser.*) calculated the valuation of a number of feeding stuffs, using its own basis of valuation, and those of the Connecticut State and Indiana Stations. The results for a few foods are here given:

Market price and valuation per ton.

	Market price per ton.	Valuation per ton.		
		Ind. Station.	Conn. Station.	N. Y. Station.
Linseed meal (new process)	$26.00	$27.48	$24.50	$27.52
Cotton-seed meal	26.00	39.72	33.19	33.47
Gluten meal	27.00	27.06	27.66	27.52
Rye feed	24.00	19.61	21.65	21.79
Corn meal	25.00	20.59	22.07	20.89
Wheat bran	24.00	19.28	22.06	22.05

These figures do not mean that cotton-seed meal, for instance, is surely worth for feeding purposes from $7 to $14 more than it costs, or that corn meal is surely worth from $3 to $4 less than the market price; nor do they mean that one is a more palatable or easily digested food than the other. They simply mean that valued on the same basis, the protein, fat, and carbohydrates in a ton of cotton-seed meal are worth from $13 to $20 more than those in a ton of corn meal, while the actual market price in this case differed by only $1 per ton. The tables of composition show the cotton-seed meal to be very much richer than corn meal in protein and fat, and the valuation shows that the protein, fat, and carbohydrates in the cotton-seed meal were very much cheaper than those in corn meal. Such indications might induce the farmer to try substituting cotton-seed meal for a part of the corn meal or gluten meal for the wheat bran.

Assuming a fixed valuation of 1 cent per pound of digestible carbohydrates and 2½ cents per pound of digestible fat, the Massachusetts State Station (*R. 1889, p. 96*) has calculated the cost of protein per pound at the current market prices of feeding stuffs, with the following results:

Cost of protein per pound in different feeding stuffs.

	Market price per ton.	Cost of protein per pound.
		Cents.
Corn meal	$29.00	5.84
Corn meal	23.00	2.72
Wheat middlings	20.00	3.13
Winter wheat bran	21.00	3.93
Dried brewers' grains	22.00	3.37
New-process linseed meal	27.00	2.68
Gluten meal	28.00	2.46
Cotton-seed meal	28.00	2.34
English hay	12.00	1.36

The subject of valuation has been discussed as follows: *Conn. State R. 1888, p. 141, B. 96; Del. B. 7; R. 1889, p. 157; Ind. B. 37; Mass. State R. 1891, p. 94; N. Y. State B. 31, n. ser.; Wis. R. 1891, p. 203.*

FOODS FOR ANIMALS, PREPARATION.—Under this heading are treated the trials on the effect of cooking, steaming, moistening, chopping, grinding, and otherwise preparing food for cattle, sheep, and pigs. Experiments abroad have indicated that cooking or steaming coarse or unpalatable food was advantageous, not on account of making the food more nutritious but in inducing the animals to eat large quantities of it. In fact it has been shown for lupine hay and some other materials that the digestibility of certain of the food ingredients, notably the albuminoids was diminished by steaming; and the cooking of potatoes, which was formerly believed advantageous, has been shown to be of no advantage whatever in case of milch cows, although it was of advantage to pigs. Julius Kühn in his book on feeding, says: "Unless large amounts of straw and coarse foods are to be fed and the supply of good hay and hoed crops is scarce, it will usually be more profitable to omit the steaming. If the reverse condition prevails, steaming will be found a very advantageous means of inducing the animals to eat sufficiently large quantities of the food."

The experiments made by our experiment stations in preparing food have been mostly with pigs.

Cooking and steaming.—Ladd reported analyses (*N. Y. State B. 5, n. ser., R. 1885, p. 315*) of cooked and uncooked clover hay and corn meal, and determinations of the digestibility of the same by artificial means. These showed that the percentages of albuminoids and fat and the relative digestibility of the albuminoids

were more or less diminished by cooking. A trial with one sheep at the Oregon Station (*B. 6*) indicated that the digestibility of silage was improved by cooking, but more extended trials are necessary to settle the question. With reference to the value of cooking or steaming food for pigs, at least thirteen separate series of experiments in different parts of this country have been reported. In these cooked or steamed barley meal, corn meal, corn meal and shorts, whole corn, whole corn and shorts, peas, corn and oat meal, potatoes, and a mixture of peas, barley, and rye have been compared with the same foods uncooked (and usually dry). In ten of these trials there has not only been no gain from cooking, but there has been a positive loss, *i. e.*, the amount of food required to produce a pound of gain was larger when the food was cooked than when it was fed raw and in some cases the difference has been considerable. In the three exceptional cases there was either no gain at all or only very slight gain from cooking or steaming, amounting to 2 per cent in one case. For further details on the subject see *Pigs, feeding.*

Experiments in feeding steamed cotton-seed to cows are reported by the Mississippi Station (*B. 15, B. 21, R. 1890, p. 26*). The results seemed to be favorable to steaming. See also *Cotton-seed and cotton-seed meal for milk and butter production.*

Moistening and soaking.—Three stations have reported comparisons of dry and wet or soaked food for pigs. The food consisted of shelled corn in one case, of a mixture of corn meal and shorts in another, and of a mixture of corn meal, shorts, and linseed meal in a third. In every case the pigs ate more of the wet food and made larger gains on it. The additional gain was usually due to the larger amount of food eaten when moistened or soaked. For further details see *Pigs, feeding.*

Roasting.—An experiment in feeding roasted cotton-seed to cows is reported in *Miss. B. 15, R. 1891, p. 26.*

Cutting and chopping coarse fodder.—The Maine Station (*R. 1890, p. 49*) compared the value of chopped and unchopped hay for cows and found no evidence that the chopping had any effect.

Cutting corn stover was found advantageous at the Wisconsin Station (*R. 1884, p. 11*) (see *Cows*).

The Indiana Station (*B. 37*) found that steers made better gains on cut than on uncut clover hay. A trial of feeding cut and uncut hay to horses has been reported by the Utah Station (*B. 13*).

Grinding.—Four stations have reported experiments on the value of grinding corn for pigs. As a rule these experiments have indicated that grinding does not pay. The Maine Station (*R. 1886, p. 59*) found that pigs digested a considerably larger percentage of the protein, carbohydrates, and fat from ground than from unground corn. One station found ground oats preferable to whole oats for fattening pigs, but not for maintenance of brood sows. For further account see *Pigs, feeding.*

As between whole and ground corn for steers, the results at two stations have been very favorable to grinding, and at a third station the results in two years were contradictory.

A trial of feeding whole and ground grain to horses is reported by the Utah Station (*B. 9*).

Foods, preservation.—See *Silos* and *Silage.*

Forestry.—This subject has excited interest chiefly in the northwestern prairie States, where, on account of extremes of climate, a forest growth is wanting and difficult to secure, and in California, where hardwood timber is specially deficient and where climatic conditions require special adaptation of species. Also in some States naturally well timbered the maintenance and utilization of the supply have been more or less considered. Investigations have naturally related to the adaptability and economic and ornamental value of native and foreign species and varieties, the best manner of treatment, and protection from insect pests. In *Ala. College B. 2, B. 3, n. ser.*, a list of the timber trees of the State is given, with notes on the economic properties of some species. In *Ga. B. 2* and *B. 3* an investigation of the

fuel value of several woods is reported, including ash analyses. *Mich. B. 32* consists of a report of a forestry convention under the auspices of the Independent Forestry Commission at Grand Rapids, January, 1888, and contains discussions of many relevant topics. *Mich. B. 39* discusses tree-planting, and on account of the insect enemies of the hard maple, elm, and locust, advocates the substitution of basswood in roadside and other plantings. *Mich. B. 45* consists of a popular appeal entitled Why Not Plant a Grove?

At the South Dakota Station the adaptations of trees to the local climate and the methods of rearing plantations have been continuously studied (*B. 12, B. 15, B. 20, B. 23, B. 29, R. 1888, p. 15*). The manner of combining species so that some more hardy, leafy, and rapid-growing trees should serve as nurses to slower-growing but more valuable sorts, especially by keeping the weeds down, has been a subject of particular study. The box elder and the soft maple have been found the best nurse trees. In an unnumbered Iowa bulletin (1885) an account is given of several Russian poplars and willows obtained from Prof. Sargent's collection and distributed for trial. These have been tried also at the South Dakota and Minnesota Stations, and are found hardy and rapid-growing, though at the former the poplars were not exempt from the attacks of the cottonwood leaf beetle. In *Iowa B. 16* a selection of trees and shrubs is recommended for planting on home grounds. *Minn. R. 1888, pp. 200, 223*, contains a few notes upon Russian willows and poplars and an account of a successful experiment in growing them from cuttings; *Minn. B. 9* contains a fuller illustrated account of this class of trees; *Minn. B. 18* contains a report of experiments in raising evergreens from seed; *Minn. B. 24* is devoted to a list of ornamental and timber trees, shrubs, and herbaceous plants, noted with reference to their hardiness and desirability for planting in the State. *Kans. B. 10* is occupied with data concerning a large number of conifers with reference to ornamental planting in that State.

In California much care has been given to the trial of exotic and American timber, shade, and economic trees in order to meet the deficiencies or enlarge the resources of that State. Among the successful or promising trees are several Australian acacias or wattle trees and eucalyptus or gum trees, the English or German oak, the cork oak, various mulberries, the camphor tree, species of cinnamon, the catalpa, the carob, and several bamboos. Eastern hardwood trees have in general been found to grow very slowly there. Cinchonas where tested proved too tender, except for a few especially warm localities. A report upon trees planted on Mount Hamilton occurs in *Cal. R. 1890, p. 267*. (See also *R. 1888–'89, p. 48, R. 1890, p. 236*.)

For data regarding individual kinds of trees see under their several names. For analyses of different woods see *Appendix, Table V.*

Forest tent caterpillar (*Clisiocampa sylvatica*).—An insect closely resembling the apple tree tent caterpillar and requiring similar treatment (see *Apple tree tent caterpillar*).

(*Colo. B. 6; Me. R. 1888, p. 164, R. 1889, p. 188, R. 1890, p. 138; Mass. Hatch B. 12; Nebr. B. 14; Ore. B. 18.*)

Fowl meadow grass.—See *Grasses.*

Foxtail grass.—See *Weeds.*

Fungi (plural of fungus).—Plants forming a great group represented by several of the lower orders and all characterized chiefly by the absence of green coloring matter (chlorophyll). Fungi are divided into two classes based upon the sources from which they obtain their sustenance. If from living plants and animals, they are called parasites; if from dead and decaying organic matter, they are known as saprophytic fungi. The plant or animal from which the fungus derives its maintenance is called a host. Some hosts are attacked by a single species of fungi, while others may harbor a dozen or more. Some fungi are restricted to a single host while others require two or three different hosts on which to pass the various phases making their life cycle.

Most fungi are comparatively simple in their life history. They have a vegetative phase corresponding to the same phase of ordinary plants and a reproductive phase more or less differentiated according to the grade of the fungus. In many of the lower orders the two phases are so closely associated as to be almost if not entirely identical. This is true of the bacteria, slime molds, and similar organisms. Among the more highly developed fungi the vegetative phase is represented by a minute, threadlike filament called a hypha. This is usually colorless, of greater or less length, and more or less branched. The hyphæ may occur singly or abundantly. In the latter case a thick, tangled mat may be formed called the mycelium, or a stem-like structure may be produced surmounted by various growths, as in the toadstools, and mushrooms. Some fungi send their filaments through the tissues of their hosts ramifying in every cell, or they may send small disk-like suckers into the cells, by which their sap is stolen and the life of the host imperiled.

The reproduction of fungi takes place in various ways. One is by division of one cell into two, both of which form complete individuals. Another is by the hyphæ sending branches to the surface of the host, or by aërial branches when the fungus is a superficial one, and from these numerous branches are developed multitudes of minute spores corresponding to the seeds of higher plants, for the immediate and rapid spread of the species; while deeper within the tissues are formed other spores by which the fungus is commonly carried over the winter or resting season. These spores, all of which are microscopic in size, are scattered everywhere by the wind and falling upon a suitable host develop new filaments. These filaments find their way into the tissues of the host, robbing it of its needed nourishment and preventing the performance of its usual functions.

As has already been said, fungi are divided into parasitic and saprophytic. They may also be classified as harmless and injurious, according to the effect they exer-upon their hosts, or as beneficial and injurious if viewed from their economic influence, either direct or indirect. The saprophytic fungi are mostly beneficial, as many of them are important scavengers. Some of those which are parasites, especially those infesting insects and their larvæ, while injurious to their hosts are highly beneficial in destroying many troublesome insects. Other parasitic fungi are injurious to cultivated plants. Among these are the fungi causing the rusts and smuts of grain, and the rots, scabs, and mildews of fruits and foliage. Associated with this class of fungi are some of the bacteria or fission fungi, for example, those thought to cause such diseases of plants as leaf blights and peach curl, and those causing anthrax, cholera, and many of the fevers of animals.

The importance of fungi as producing diseases of many kinds was not recognized until within very recent years, and the various experiment stations are doing good work in studying the life history of fungi from both a scientific and an economic standpoint.

Fungicides.—The various preparations used in the treatment of fungous diseases of plants are as a rule preventive remedies, and their successful use depends very largely on early and repeated applications. No fixed rule can be laid down as to when and how often fungicides should be used. Many diseases are greatly checked by drenching or washing the trees, shrubs, or vines before the buds begin to show, with a mixture of greater strength than that given in the ordinary formulas. For this purpose formulas 1 and 2, given below, may be used in double or triple strength. In some cases a second spraying should follow the falling of the flowers. Rain following soon after the application of fungicides is likely to wash them off. In such cases spray again as soon as possible after the rain. Care must be exercised not to use fungicide solutions which will injure foliage. In preparing fungicides it must be remembered that ordinary commercial chemicals vary in strength. For vegetables and annual plants in general the first spraying should be done after the plant is well up and in vigorous growth. The succeeding sprayings should be made at intervals of about two weeks throughout the season. Particular courses of treat-

ment are required for some diseases. The spraying should be thoroughly done so as to reach the whole plant, but care should be taken not to use too much of the fungicide. A small quantity thrown over a plant in the form of a very fine spray will do more good than a much greater amount imperfectly applied. A gallon or a gallon and a half should spray a tree of average size. The disease must first be determined and the treatment fitted to the disease. The indiscriminate use of fungicides may do more harm than good. Experience shows that Bordeaux mixture or ammoniacal carbonate of copper solution may be properly used for numerous diseases. An objection to Bordeaux mixture, especially on fruits, is that it leaves quite a deposit of solid material. This may, however, be easily washed off from the fruit with a solution of vinegar (2 quarts to 10 gallons of water). All fungicides should be kept in wooden, glass, or earthen ware, never in iron vessels.

Formulas for the more common fungicides, with brief directions for their preparation and use, are given below:

(1) Simple solution of copper sulphate.—Copper sulphate (blue vitriol or blue stone). 1 pound; water (soft), 22 gallons. Dissolve the copper in the water. This solution will keep indefinitely. It will cost about one-fourth of a cent per gallon. Paris green or London purple (2 ounces to 22 gallons) may be added and the mixture may be used as a combined insecticide and fungicide.

(2) Simple iron sulphate solution.—Iron sulphate (copperas), 5 pounds; soft water, 22 gallons. Dissolve the copperas and use at once. It costs about one-half cent per gallon. Insecticides may be combined with this fungicide.

(3) Bordeaux mixture.—Copper sulphate (blue vitriol), 6 pounds; unslaked lime, 4 pounds; water, 22 gallons. Dissolve the copper in 16 gallons of the water and slack the lime in the other 6. Stir the lime well and strain the thin whitewash into the copper solution, stirring it well. Always observe this order of preparation, as it is said to spoil the mixture if the copper be poured into the lime. Keep well stirred and use at once. The tendency this mixture has to fill up the nozzle of the sprayer is its greatest drawback. Paris green or London purple (2 ounces to 22 gallons) may be combined with this fungicide. It costs about 1⅛ cents per gallon.

In another formula 4 instead of 6 pounds of copper sulphate is used, with about as good results.

(4) Eau celeste.—Copper sulphate, 1 pound; ammonia (22°), 1½ pints; water, 22 gallons. Dissolve the copper in 2 gallons of hot water. When cool add the ammonia and reduce to 22 gallons. This costs about a cent per gallon. Insecticides can not be used with this.

(5) Modified eau celeste.—Copper sulphate, 2 pounds; soda carbonate (washing soda), 2½ pounds; ammonia (22°), 1½ pints; water, 22 gallons. Dissolve the copper in 2 gallons of hot water and the soda in a like amount. Pour the soda into the copper solution and mix thoroughly. Add remainder of the water and use at once. This mixture will cost about 1⅓ cents per gallon. No insecticide can be used with it.

(6) Burgundy mixture.—Copper sulphate, 2½ pounds; soda carbonate, 3½ pounds; hard soap, ½ pound; water, 22 gallons. Dissolve the copper in 12 gallons of water, the soda in 10. Strain the soda solution into the copper and stir well. Dissolve the soap in a half gallon of hot water and stir into the above solution. Never put this in an iron vessel. It should be used at once. Insecticides can not be used with this mixture. It will cost about 1½ cents per gallon.

(7) Ammoniacal copper carbonate compound.—Copper carbonate, 3 ounces; ammonia carbonate, 1 pound; water, 50 gallons. Dissolve copper and ammonia carbonate in a half gallon of hot water. Dilute to 50 gallons and use at once. Insecticides can not be used with this. Cost of this mixture about one-half cent per gallon.

Another formula for this solution is as follows: Copper carbonate, 3 ounces; ammonia (22°), 1 quart; water, 22 gallons. Dissolve copper in the water, add ammonia, and use at once.

A third formula is copper carbonate, 1 ounce; ammonia carbonate, 6 ounces. Powder and mix thoroughly. This may be kept in a dry state in air-tight vessels for any length of time. When needed for use dissolve in 10 gallons of water and use at once.

A fourth formula, which is said to be equal to any of the others and a little cheaper, but which has not been tested as much as the others, is copper sulphate, ½ pound; ammonia carbonate, 1 pound; water, 62 gallons. The ammonia carbonate should be hard and transparent, otherwise 1¼ pounds will be needed. Dissolve it in a pail of hot water. When foaming ceases add copper and stir as long as there is any foaming. Dilute to 62 gallons and use at once.

These four formulas are practically the same or nearly so, and the solution formed is one of the most valuable with which to combat plant diseases. Without the objectionable feature of the Bordeaux mixture it probably ranks next that in efficiency. However, insecticides can not be used with any of these, as they can with the Bordeaux mixture.

In none of the solutions containing ammonia or carbonates in any form should Paris green or London purple ever be used, unless a quantity of lime is added, as the chemical compounds thus formed are injurious to foliage.

(8) Potassium sulphide solution.—Potassium sulphide, ¼ to ½ ounce; water, 1 gallon. Dissolve and apply at once. This is one of the best of fungicides, but is more expensive than some of the others.

(9) Copper and sulphur powder.—Copper sulphate, powdered, 1 pound; sulphur, 10 pounds; air-slaked lime, 1 pound. Mix thoroughly and apply with any apparatus for spraying powders.

(10) Nessler's powder.—Copper sulphate, 1 pound; air-slaked lime, 2 pounds; gypsum or road dust, 10 pounds; water, 1 gallon. Dissolve the copper in the hot water; sift the lime in the solution. Mix gypsum or road dust with this and stir very thoroughly. This mixture is worthless if kept for more than three days. One ounce of Paris green or London purple as an insecticide may be added to the above if desired.

Hot water.—This is used as a fungicide chiefly in the so-called Jensen treatment for smuts of grain. For this treatment two large kettles over a fire or two wash boilers over a stove, and a reliable thermometer will be needed, as well as a coarse sack or covered basket to hold the seed. A special vessel to hold the grain may be made of wire or perforated tin. Never entirely fill the vessel with grain, and have in the kettles about five or six times as much water as there is grain in the basket. In the first kettle keep the water at from 110° to 130° and in the other at 132° to 133°, never letting it fall below 130° lest spores will not be killed, nor rise above 135° lest the grain be injured. Place the grain in the basket and then sink it into the first kettle. Raise and lower it several times or shake it so that all may become wet and equally warm. Remove it from this and plunge it into the second kettle, where it should remain for fifteen minutes. Shake about several times while in this kettle. If the temperature falls below 132° let it remain a few moments longer; if it rises, a few less. Have at hand cold and boiling water with which to regulate the temperature. Remove at the expiration of fifteen minutes and plunge into cold water, after which spread to dry. The seed may be sown at once, before thoroughly dry, or may be dried and stored until ready for use. For treating oats, keep them in the water at 132° for only ten minutes and spread to dry without plunging into the cold water. If this method of treatment be followed and no smut be in the ground or manure, no smut will be found in the coming crop or the amount will be so small as to be insignificant. On the other hand, the increased yield will more than pay for the trouble and time of treating.

Spraying apparatus.—Of the various devices for this purpose, two kinds are in common use. One is the knapsack sprayer, for use by a single individual, where a relatively small amount of spraying is to be done. It is sufficiently large for the spraying required in a garden or vineyard less than 10 acres in extent. As the name

indicates, it is to be carried on a man's back. The price of such a machine, with brass fittings, is about $14. For larger vineyards and orchards a double-acting force pump, arranged to be hauled by one or two horses, is advisable. These can be had at various prices, depending somewhat upon the capacity of the machine.

One of the most important parts of the sprayer is the nozzle. It must give a good, fine spray, and be not easily clogged, easily cleaned when clogged, and easily regulated. The Vermorel nozzle is undoubtedly one of the best for Bordeaux mixture and the Climax for clear solutions. It is well to have one of each of these nozzles. In selecting apparatus there is no economy in choosing cheap fixtures where brass can be had at a small advanced price. The copper sulphate will soon corrode iron or tin fixtures.

(*Conn. State B. 102, R. 1890, p. 104; Del. B. 3, B. 6; Ill. B. 15; Ind. B. 32, B. 38; Kans. B. 12, B. 22; Ky. Cir. 3; Mass. Hatch B. 7, B. 11, B. 13, B. 17; Mass. State B. 39; Mich. B. 59, B. 83; Minn. B. 13; Mo. B. 13; N. J. B. 86, R. 1890, p. 335; N. Y. State R. 1887, p. 348, R. 1888, p. 153, R. 1890, p. 102; N. Y. Cornell B. 35; N. C. B. 76; Ohio B. vol. III. 4, 8, 10; Ore. B. 10; Pa. R. 1888, p. 159; R. I. B. 15; Tenn. B. C; W. Va. B. 21.*)

Gama grass.—See *Grasses.*

Garget.—See *Mammitis.*

Garlic.—See *Weeds.*

Gas lime.—See *Lime.*

Georgia Station, Experiment (near Griffin)—Organized in 1888 as a department of the State College of Agriculture and Mechanic Arts. The staff consists of the president of the college, director, vice-director and chemist, assistant chemist and meteorologist, agriculturist, horticulturist, secretary, and dairyman. The principal lines of work are field experiments with fertilizers and crops, horticulture, and dairying. Up to January 1, 1893, the station had published 4 annual reports and 19 bulletins. Revenue in 1892, $22,000.

Germination of seeds.—See *Seeds.* For references to germination tests of seeds, see under the names of different plants.

Gid of sheep.—See *Sheep, gid.*

Geology.—The geological work of the stations has been comparatively limited, and very naturally has been confined almost exclusively to investigations relating to the origin, formation, and classification of soils (see *Soils*). An officer called a geologist is employed at the stations in California, Louisiana, and Wyoming.

Gingko (*Gingko biloba* [*Salisburia adiantifolia*]).—The gingko or maidenhair tree at the Kansas Station (*B. 10*) was found, contrary to expectation, to succeed fairly well. In some seasons the shoots were injured by severe frosts and the trunk was exposed to sun-scald; but it is judged likely to succeed in good soil and protected situations. In *Minn. B. 24* it is stated that a few specimens have grown well near Minneapolis for six years without protection.

Glanders.—This disease and farcy are but different manifestations of the same affection. It is a malignant, infectious disease, due to the presence of a specific microörganism (*Bacillus mallei*). It is one of the oldest diseases of which we have any knowledge and is contagious among horses, mules, and asses. It may be communicated by the infection getting into wounds of sheep, goats, dogs, rabbits, guinea pigs, and even of man. It runs a variable course, nearly always resulting in the death of the animal. The disease affects chiefly the lungs, mucous lining of the nasal passages, and the lymphatic glands. These are the organs primarily affected, but with the progress of the disease no part of the body is exempt from its effects. It is not contagious in the ordinary sense of the word, but is transmitted through food or drink or by coming in contact with the nasal discharges of infected animals in the stable or at hitching posts.

The symptoms of the disease in one of its ordinary forms so resemble those of chronic catarrh as to render the correct diagnosis sometimes difficult. One of the

most common forms of glanders may be called "nasal" glanders, from the fact that the nose is the part most conspicuously affected. It seems to be both chronic and acute, differing in degree. The animal will have a discharge from its nose, at first thin and watery, but later becoming thick, of a dark color, and resembling linseed oil. If the nose be examined pustules or pimples of varying size will be found on the inside, most abundant upon the septum or division between the nostrils. These are hard at first and of a grayish color, but they soon soften and break down, furnishing the peculiar discharge. Often the submaxillary glands, just inside the lower jaw bone at the base of the tongue, will be enlarged and hard. Whichever nostril is discharging, the gland on that side will be affected and may be felt from the outside just at the angle of the jaw. An ordinary chronic state of the disease may continue for years. In an acute state the symptoms are greatly aggravated. The form usually called farcy attacks the lymphatics more prominently, causing the swelling of the legs, especially the hind ones, neck, and face. Numerous hard, button-like swellings may be felt through the skin. These are the farcy "buds" or farcy "buttons," and they finally become soft and discharge a characteristic secretion. Before softening the buttons are hot and tender to the touch. Another form attacks the lung and air passages and is more difficult of diagnosis. Of the above symptoms, all may be present in one case and most of them absent in another. It is the variable character of its symptoms that makes it difficult to limit or define the disease, and none but a competent veterinarian should pass upon a suspected case.

There is no treatment for the disease that will effect a cure. Good care, good food, and little work may enable the animal to live for years in comparative health, but a sudden change in these conditions may develop the disease at once. All affected animals should be killed at once, as they are capable of spreading the disease, no matter how slight their attack, and death is the ultimate result in any case. (*Ark. R. 1889, p. 105; Mich. B. 78; Miss. B. 16; S. Dak. B. 25.*)

Gluten meal.—This material is obtained as a by-product in the manufacture of starch and glucose sugar from corn. It consists largely of the germ (chit), the richest part of the corn, with more or less hulls and starch. The supply of this substance has acquired considerable proportions in consequence of the development of the glucose industry in this country. As shown by the analyses given in *Appendix, Table I*, it is a richly nitrogenous material, and it has found quite extensive use for feeding animals. The variations in composition are mainly due to modifications in the process of manufacture.

GLUTEN MEAL FOR MILK AND BUTTER PRODUCTION.—In 1883 the New York State Station (*B. 34, B. 35*) reported trials with gluten meal which indicated that, as compared with bran or corn meal, it was most profitable for milk production. "It surfeits the cattle easily and becomes unpalatable to them. Our impression is that unless fed with care it may prove an injurious food."

Later the Massachusetts State Station (*R. 1884, p. 42*) fed it with an equal weight of wheat bran "to compensate for its deficiency in phosphates of lime and magnesia and to render it more palatable. The desired amount of both substances was mixed and moistened and fed during milking." The results following the feeding were satisfactory and indicated it to be a valuable feeding stuff. It was compared with cotton-seed meal and old-process linseed meal (*B. 41*), with the result stated under *Cotton seed and cotton-seed meal.*

The New York State Station (*B. 9, n. ser.*) reports a case in which two cows died after being fed 8 quarts of gluten meal daily in connection with 4 quarts of middlings and corn-and-cob meal. This furnishes an excessive amount of albuminoids "which experience has shown is likely to produce sickness, and, if followed up, death. Our verdict must be: "The fault is in the user, not in the material." In a feeding trial at New York State Station (*R. 1889, p. 198*) gluten meal (6 pounds per day) gave a larger yield of milk than either corn meal, ground oats, or linseed meal, although the latter was poorly eaten; but the indications were that the gluten meal did not increase the solids and fat in proportion to the yield of milk.

The New Hampshire Station (*B. 13*) observed that gluten meal almost invariably increased the milk yield over corn meal, but made no mention of the quality.

The Iowa Station (*B. 14*) found that as compared with corn-and-cob meal, gluten meal improved the quality of the milk and decidedly increased the total amount of solids and fat contained in the milk (see also *Milk, effect of food*).

Gluten meal appears to exercise an effect on the churnability of the milk fat and on the quality of the butter, as mentioned under *Butter-making, effect of food on churnability and on quality of butter.*

GLUTEN MEAL FOR BEEF PRODUCTION.—Gluten meal was fed in a ration with other grain foods to steers at Massachusetts State Station (*B. 40*). See also *Cattle.*

Golden hawkweed.—See *Weeds.*

Golden-rod.—See *Weeds.*

Gooseberry (*Ribes grossularia*).—Varieties have generally been planted for testing at the Northern stations, and insect pests have been the subject of some investigation. Tests of varieties are reported in *Cal. R. 1888–'89, pp. 88, 110, 197; Colo. R. 1888, p. 85, R. 1889, pp. 24, 30, R. 1890, p. 200; Del. R. 1889, p. 103; Ill. B. 21; Ind. B. 5, B. 10, B. 31, B. 33; Iowa B. 16; Me. R. 1889, p. 256; Mass. Hatch B. 4; Mich. B. 55, B. 59, B. 67, B. 80; Minn. R. 1888, pp. 236, 285; N. Y. State R. 1885, p. 230, R. 1886, p. 257, R. 1887, p. 339, R. 1888, pp. 96, 100; N. C. B. 72; N. Dak. B. 2; Ohio R. 1884, p. 129, B. vol. II; 4 Pa. B. 8; R. I. B. 7; Tenn. R. 1888, p. 12; Vt. R. 1888, p. 118, R. 1889, p. 122, R. 1890, p. 184; Va. B. 2.*

Gooseberry seed was used in a germination test, as reported in *Vt. R. 1889, p. 112.*

For the cape gooseberry see *Physalis.*

Gooseberry mildew (*Sphærotheca mors-uvæ*).—This fungus appears as a downy coating of the leaves, young shoots, and berries.

In its early stage it is white from the innumerable summer spores; later it becomes brownish, dotted with black specks, the winter stage. The first stage may be checked and the second prevented by the use of a solution of potassium sulphide (one-half ounce in 1 gallon of water). This should be used as a spray, beginning as soon as the leaves expand, at intervals of two weeks during the growing season (*N. Y. State, R. 1887, p. 339, R. 1888, p. 153, B. 36 n. ser.*).

Grain beetle (*Sylvanus surinamensis*).—This is a small, brownish-colored beetle, one-tenth of an inch long, that sometimes infests stored grain. It is liable to be more abundant where the grain has become damp or heated in the bin. It is sometimes called the wee grain weevil, and when abundant may cause considerable loss.

Bins should be kept clean and well aired. If this insect should get into the grain, treating with the fumes of bisulphide of carbon will kill it. Care must be taken to avoid breathing the fumes, as they are very poisonous. All fire should be kept away for fear of its igniting the fumes (*Mich. R. 1889, p. 94; Ore. B. 5, B. 14*).

Grain feeds.—See *Foods.*

Grain louse.—See *Plant lice.*

Grafting.—Methods of grafting trees and vines, and suitable stocks for different species are considered in the station literature in connection with accounts of work on various plants (see especially *Cherry, Cottonwood, Grape, Pear,* and *Plum.*)

Work in herbaceous grafting is reported in *N. Y. Cornell B. 25.* The object was primarily to learn the best methods of grafting herbs, but a second object, considered more important, was the study of the reciprocal influences of stock and scion. Results from the latter inquiry have not been published.

Six hundred experimental grafts were made. It was found that the wood must be somewhat hardened to obtain the best results, but the stock must not have ceased from growth. Various styles of grafting were employed, of which the common cleft and the veneer or side graft were deemed to be perhaps the most satisfactory. "In most instances it was only necessary to bind the parts together snugly with bast or raffia. In some soft-wooded plants, as coleus, a covering of common grafting

wax over the bandage was an advantage, probably because it prevented the drying out of the parts. The best results were obtained by placing the plants at once in a propagating frame, where a damp and confined atmosphere could be maintained." Many other suggestions are made and a number of plants are mentioned between which successful unions were secured "Coleuses of many kinds were used, with uniform success, and the scions of some of them were vigorous a year after being set. Zonale geraniums bloomed upon the common rose geranium. Tomatoes upon potatoes and potatoes upon tomatoes grew well and were transplanted to the open ground, where some of them grew, flowered, and fruited until killed by frost. The tomato on potato plants bore good tomatoes above and good potatoes beneath, even though no sprouts from the potato stock were allowed to grow."

Gramma grass.—See *Grasses.*

Grape (*Vitis* spp.).—Grapes have been very extensively grown to test varieties, study method of culture, and investigate the enemies of vine and fruit. In California the object chiefly in view has been wine and raisin production.

Variety tests are reported in *Ala. College B. 3, n. ser., B. 10, n. ser., B. 29, n. ser.; Ala. Canebrake B. 6, B. 12; Ark. B. 7, R. 1888, p. 44, R. 1890, p. 46, B. 17; Cal. B. 8 (1875), R. 1888–'89, pp. 88, 111, 138, 197, R. 1890, pp. 193, 297; Colo. R. 1889, pp. 24, 119, R. 1890, p. 35, R. 1891, p. 109; Fla. B. 14; Ga. B. 11; Ill. B. 21; Ind. B. 5, B. 10, B. 33; Iowa B. 7, B. 16; Kans. B. 14, B. 28; La. B. 22, B. 8, 2d ser.; Md. B. 15; Mass. Hatch B. 4, B. 17; Mich. B. 55, B. 59, B. 67, B. 80; Minn. R. 1888, pp. 218, 299; Miss. R. 1890, p. 36, R. 1891, p. 31; Mo. B. 10; Mo. College B. 20, B. 26; Nev. R. 1890, p. 30; N. Mex. B. 2, B. 4; N. Y. State R. 1885, p. 225, R. 1886, p. 167, R. 1887, p. 341, R. 1889, p. 344, R. 1890, p. 325; N. C. B. 72; Ohio R. 1883, p. 147; Pa. B. 18; R. I. B. 7; Tenn. B. vol. V, 1; Tex. B. 8; Vt. R. 1888, p. 118, R. 1889, p. 122; Va. B. 2; Wis. B. 13, R. 1888, p. 157.*

The keeping quality of many varieties was tested at the Mass. Hatch Station (*B. 17*).

The number of varieties tested is very large, running as high, though not often, as 165. The varieties are sometimes classified according to the species from which they are derived, as in *Ark. R. 1890, p. 46, B. 17,* and *Tex. B. 8.* Some account of the species and their respective derivatives is given in *Ark. R. 1890, p. 48; Minn. R. 1888, p. 218.* The species noted are *Vitis vinifera,* the European wine grape, not successful in this country except in California; *V. labrusca,* the Northern fox grape, the source of by far the largest number of the valuable American grapes; *V. cordifolia* or *riparia* (these are now regarded as distinct species), the winter or frost grape; *V. vulpina* of the South, source of the Muscadine variety; *V. æstivalis,* a summer grape; and *V. rupestris.* In *Cal. R. 1888–'89, p. 197,* a list of 145 varieties of the *vinifera,* cultivated at the stations of that State, is given, grouped according to 14 types; also of 2 American hybrids and of 21 American and 3 Asiatic wild vines. In *Minn. R. 1888, p. 221,* are given engravings of the seeds of 12 varieties of different derivations, showing marked diversity in form and size.

At the California Station the native American species have been carefully investigated with reference to their power of resisting Phylloxera and their fitness in other respects for use as grafting stocks for *vinifera* varieties (*Cal. R. 1880, p. 84, R. 1882, p. 94, B. 34, B. 74,* and especially *Viticultural R. 1885–'86, p. 141*). The merits of *V. riparia, V. cordifolia, V. æstivalis,* and *V. rupestris,* from the Eastern States, and of *V. californica,* and *V. arizonica* from the West are presented and compared. The *californica* as a local native is considered to have a strong presumption in its favor, and this is found to be confirmed by trial, so far as it is planted in the appropriate soils. These appeared to be such as are fertile, heavy, and rich in lime. The general adaptation of this vine is shown in its root habit, which is strongly downward, insuring access to moisture. Its soft root is scarred by the bite of Phylloxera, but escapes the deformity which is the cause of ultimate death in the case of non-resistant vines. Excellent success was obtained in grafting, and this stock had the special advantage in comparison with the *riparia* and *rupestris* that it was not out-

grown in diameter by the *vinifera* varieties when grafted upon it. Only one exception had been found to this rule. Its seedlings are very vigorous and suitable for stock; and it starts later in the season, thus encountering less danger from frost. Various other stocks, however, are equally resistant and have good points. The *arizonica* was thought to deserve more attention than it had received. It had the advantage over all others that its stem is undivided for from 4 to 6 inches above the ground, thus facilitating grafting. The *riparia* seemed to be a proper stock for certain delicate varieties (*Cal. B. 74*); with strong-growing kinds exceeding it in diameter it bears heavily at first (as when a tree is girdled), but its vitality and resistant power are soon exhausted.

Numerous analyses of Eastern grapes are contained in the Massachusetts State Station compilations (*R. 1889, p. 303, R. 1890, p. 302, R. 1891, pp. 296, 328*). The composition of wild and cultivated grapes is compared and the effects of girdling the vines and of fertilizing are illustrated. Some ash analyses are given (see *Appendix, Table III*). Analyses of fruit from girdled and not girdled vines may also be found in *Mass. Hatch B. 7*. An estimate of fertilizing ingredients withdrawn by a grape crop is given in *Cal. B. 88*, and an analysis of dried grapes with reference to food and ash constituents in *Cal. B. 97*.

General directions for the culture of grapes may be found in *Ala. College B. 4, n. ser., B. 10, n. ser., B. 29; Ark. R. 1888, p. 41, R. 1890, p. 46, B. 17; Iowa B. 7; Pa. R. 1888, p. 158; Wis. B. 13, R. 1888, p. 157*. In *Minn. R. 1888, p. 297*, the best climatic conditions are discussed for grapes during five periods, into which their growing season is divided. At the Iowa Station (*B. 7*) deep setting was found efficacious against winterkilling of the roots, and covering the tips of the vines with soil, together with a slight mounding about the crown of the root, were found a sufficient winter protection.

In *Cal. B. 3* reasons for the failure of cuttings are discussed, one of them being, as believed, the planting of long cuttings with a crowbar instead of using a spade. The lower end is thus commonly left without contact with the soil and exposed to decay. In *Pa. R. 1888, p. 158*, pinching off the ends of the fruit-bearing shoots in summer is advocated.

Notes on pruning and training occur among the general directions for culture. Methods of grafting vines are discussed at some length in *Cal. R. 1882, p. 96*. The English cleft graft or whip graft had been adopted, chiefly on the ground of its adaptation to stocks of small diameter. The favor which this method has won in France is believed to be due to its merits, and it is shown not to involve an unreasonable expense. The general methods of treating the stocks and the attendant circumstances, as well as the results of two years' grafting, are shown in detail.

The practice of girdling vines to promote fruitfulness has been investigated at the Massachusetts Hatch Station and elsewhere under its influence (*B. 7, B. 13, B. 17, R. 1888, p. 18*). The girdling consisted in removing a section of bark on the branch above the point where it would be pruned off the next year or in compressing the branch with wire. The ripening of the fruit was hastened sometimes as much as ten or eleven days and the size also increased without loss of palatability if picked in good season. In a wet season the berries tended to crack open and to be too soft for marketing. The fruit on the branches not girdled was reduced in value. Observations also seemed to show that girdling is a draft on the future life of the vine. There was evidence that girdling will not pay except where normal ripening can not be secured, and where after a season's girdling the vines may be allowed a year to recover.

The favorable influence of electric currents upon vines as shown by a European experiment is noted in *Mass. Hatch B. 16*.

Experiments have been made at several stations in bagging grapes as a means of protection from fungus and insect enemies and birds. (*Ala. Canebrake B. 12; Ala. College B. 10, n. ser.; Kans. B. 28; Minn. R. 18; N. J. B. 82; N. Y. State R. 1886, p. 168.*)

The bags are generally of manilla paper of the 1 or 2 pound size, with a hole at the bottom to permit the escape of water. They are slit on each side, drawn over the cluster and pinned upon the branch. They are found to afford an excellent protection against all enemies that affect the fruit, even hailstorms, and also to secure finer-appearing clusters. At the Alabama Station, however, bagging was not found equally advantageous for all varieties and some were better without the sacks.

Grape, anthracnose.—See *Anthracnose of grape.*

Grape, bitter rot (*Melanconium fuliginea*).—This attacks the grapes at any time after they begin to ripen and continues until maturity. Great moisture is necessary for the rapid development and spread of this disease. Coming late in the season it is to be dreaded as it may destroy what the other earlier diseases have not. The fungus attacks the shoots, the stems bearing the grapes, and the berries. Most damage is done to the fruit. A rosy discoloration, most noticeable in the light-colored varieties, is the first manifestation of its presence. This discoloration extends rapidly until the whole berry is involved. The grapes retain their original shape for some time, being but little wrinkled and more juicy than usual. In a few days small pimples appear on the surface, from which spores escape to spread the disease. The berry then becomes shriveled and brown or purple, but not black as in black rot. Finally the berries loosen their hold upon their stems and fall at the least jar, while in black rot they remain, falling only with their pedicels. It is usually most abundant upon plants already weakened by mildew or other diseases. No remedy is known. It rarely is severe in its attacks on plants that have been treated for other diseases. (*N. Y. State R. 1890, p. 325.*)

Grape, black rot (*Læstadia bidwellii*).—This is one of the most serious diseases of the grape and the annual loss to the growers from this cause is enormous. It is most abundant in regions and seasons where there is considerable moisture and subsequent high temperature, while in dry and hot climates it is nearly unknown.

Certain varieties are more susceptible than others. The fungus attacks both the leaves and the fruit. The appearance of spots upon the leaf will be seen from one to three weeks before any indications are shown upon the berry. The spots on the leaves are seldom large, but are distinctly marked, being of a dark reddish-brown color. These spots may appear quite soon after the leaves are put out and are still tender. In this case some of them will be killed. If the attack on the leaf occurs later but little apparent damage is done them.

The rot first appears on the berry as a light brown spot caused by the decay of the underlying pulp. This spot increases in size until the entire berry is involved. At the same time the original spot becomes darker and then black and is covered with minute black pustules or pimples. Finally the whole berry dries and shrivels, crumpling the skin into angular folds. At this time the entire berry is covered with pustules, from which spores escape to spread the disease. This is only one of several ways by which it may be propagated. There are usually two periods of infection; the first is mild and upon the young berries, the other is later and more severe. Quite commonly some of the berries on each cluster are not affected by the rot.

Sometimes the disease is continued into the ripening season, when the berry becomes very black; the skin is distended, and decay is finished without the usual shriveling of the skin. The benefit derived from the proper use of fungicides to prevent this disease is well established. If the vines are well washed with a solution of copperas or blue vitrol (about 1 pound to 4 or 5 gallons of water), before the buds begin to swell, and this is followed with Bordeaux mixture or copper carbonate, the loss will be greatly lessened, if not entirely prevented. If the Bordeaux mixture is used the fruit is liable to show a discoloration due to a deposit of copper and lime upon the skin. This may be removed by washing the grapes in water, weakly acidulated with vinegar or acetic acid, and thoroughly rinsing afterward. Perhaps a better way would be to spray once or twice early in the season with the Bordeaux mixture and for subsequent treatment use the ammoniacal carbonate of copper, which does

not stain the fruit. The amount of copper deposited on the fruit is not sufficient to cause any harm when eaten. (*Conn. State B. 111, R. 1890, p. 100; Del. B. 6; Ind. B. 38; Iowa B. 13; Mich. B. 83; N. Y. State R. 1890, p. 318; Tenn. B. vol. IV, 4.*)

Grape, downy mildew (*Peronospora viticola*) [also called Brown rot].—The same fungus causes two forms of disease. If the leaf is attacked the disease is called downy mildew; if the fruit, brown rot or gray rot. It also attacks the young shoots. Leaves affected by this fungus show upon their upper surface spots of a greenish yellow or light-brown color, while on the lower side of the leaf, opposite these spots, may be seen a peculiar downy or frosty growth.

These spots may be quite small and few in number or very abundant, the frosty growth almost covering the lower surface. In the smooth-leaved varieties of grapes this will be very conspicuous and striking. When the fungus is abundant the leaf soon yields to the disease, turns brown, and falls from the vine. In severe cases the disease extends to the young branches, which are checked in their growth or killed. It produces dark-colored, sunken markings, caused by the decay of the underlying tissues, but the epidermis is not lacerated nor does the spot resemble that of anthracnose. The attack upon the fruit is said to be quite early, causing many of the berries to cease growing, turn brown, and fall off. At other times the attack does not occur until the fruit becomes nearly full grown. Purplish brown spots appear, the whole berry soon turns brown, and the pulp becomes soft and shrunken, leaving the wrinkled skin unbroken. In the gray rot many filaments thrust themselves through the skin and form summer spores. From the abundance of these, a grayish color is given the fruit. Unlike the powdery mildew, the downy mildew sends its mycelial threads through the tissues of the host and when once attacked no relief can be secured. This fungus also attacks the Virginia creeper or woodbine.

In treating grapes for this disease eau celeste or Bordeaux mixture may be used with good results. In some respects the former is to be preferred. Early washing of the vines is of advantage in freeing them from spores which may have found lodgment in the crevices of the bark. The first spraying should be about ten days before blooming, the next a week after, and two or three more should be made during the season. *Conn. State B. 111; Ohio B. vol. III, 10; Mass. R. 1890, p. 222; Mich. B. 83; N. Y. State R. 1890, p. 320; Tenn. B. vol. IV, 4.*)

Grape, leaf blight (*Cerospora viticola*).—This disease is usually first noticed upon the lower leaves or wherever they are thick and shaded. It appears in small brown spots an eighth of an inch or less in diameter, with a darker colored border. These spots extend through the leaf. The upper surface of the spot is very smooth but by the aid of the lens the lower side shows numerous hairlike projections. As the disease progresses the tissues of the leaf next the spot become yellow and finally the whole leaf may die. When rather abundant, this disease may cause serious loss by depriving the vines of their leaves. Only one form of this fungus is now well known, but there are probably others not yet found. No remedy is known for this particular disease, but it is not liable to be troublesome on vines which have been treated for black rot or anthracnose. (*N. Y. State R. 1890, p. 324.*)

Grape-leaf folder (*Desmia maculalis*).—The adult moth is about one-half inch long and nearly 1 inch across its expanded wings. It is black, with white markings about the middle and toward the tip of its wings. There are two broods per season. The eggs are laid upon a leaf and upon hatching the young caterpillar folds the leaf, holding it together by a delicate web. Inside of this it feeds until either the leaf is killed or the worm grows too large for its quarters, when it moves to a larger leaf, folding and fastening it as before. The mature caterpillar is about three-fourths of an inch long, of a yellowish-green color, with numerous hairs over its body. When abundant several caterpillars may be found folded in one leaf.

The usual way to destroy them is to crush them in any leaf folded together. They are very active and often escape, falling to the ground.

The leaves should be burned in the fall, as the insect winters as a chrysalis in the folded ones. Poisoning is difficult to accomplish, owing to the protection given by the folded leaf. Hand picking is perhaps the most successful treatment. (*Ark. R. 1888, p. 123, R. 1889, p. 144; S. C. R. 1888, p. 37; Tex. B. 8.*)

Grape, powdery mildew (*Uncinula spiralis*).—This disease usually makes its appearance about the middle of summer and continues until frost. It attacks the leaves, young shoots, and fruit, covering them with a powdery growth. It differs from the downy mildew in covering the upper surface of the leaves with white patches of various size and shape. Sometimes it spreads quite evenly over the surface and somewhat resembles a delicate spider's web. It does not send filaments into the tissues of the host plant, but taps the epidermal cells with numerous and minute suckers, or haustoria as they are called, and through these saps the adjoining cells, while all the filaments are spread out on the surface of the leaf. The fruit when affected shows upon the surface a whitish dust. This rapidly increases in abundance and soon the berries begin to shrivel and their skin cracks, admitting other spores of decay which soon complete the destruction of the fruit. Late in the season numerous brown specks may be seen among the filaments. These are the forms in which the fungus is carried over the winter. Being confined to the surface this fungus yields to the application of almost any of the fungicides, but sulphur is probably one of the best. (*Ind. B. 38; Mich. B. 83; N. Y. State R. 1890, p. 322; Vt. R. 1890, p. 143.*)

Grape sawfly (*Selandria vitis*).—The larva of this fly is about one-half inch long, yellowish green, with black points. There are usually two broods. Its habit of feeding makes it easy to combat. If not very abundant, plucking the leaves and crushing the larva under the foot will destroy them very well. If more abundant, arsenites or white hellebore may be employed (*N. J. R. 1889, p. 304; S. C. R. 1888, p. 38*).

Grape, white rot (*Coniothyrium diplodiella*).—This in general is very much like the black rot fungus. It produces minute pimples under the skin of the grape just as the berries are beginning to ripen. The pimples first appear as shining rosy points, becoming white, and later brown. No remedy is known for white rot, but it is never so prevalent where vines have been treated for black rot as upon untreated ones. (*N. Y. R. 1890, p. 324.*)

Grasses.—This article contains short accounts of the more important grasses, and brief mention of some species of minor importance which have been tried at the stations. Tests of numerous species are now in progress at the stations, especially those in California, Colorado, Connecticut, Florida, New York, Michigan, Mississippi, North Carolina, Tennessee, and Texas.

Bent grasses (*Agrostis* spp.).—Redtop or Herd's grass (*A. vulgaris*), fiorin and creeping bent grass (*A. alba* and *A. stolonifera*), and Rhode Island bent grass (*A. canina*) are all very similar. They are perennials, growing 2 or 3 feet high from creeping root stocks. The number and interlacing habit of the roots makes one of the most dense sods known. The culms are either upright or bent at the base; are smooth, round, rather slender, and bear four or five flat, narrow, roughish leaves from 3 to 6 inches long. These grasses do best in moist places, forming fine pasture where it is too marshy for anything else. They will also grow upon drier soil and endure drought very well. They will bear overflowing, although the water may stand for two or three weeks. They seem adapted to any part of the United States and are greatly appreciated as pasture grasses. (*La. R. 1891, p. 12; Minn. B. 12, R. 1888, p. 183; Miss. R. 1890, p. 30; Nebr. B. 6, B. 12, B. 17; Nev. R. 1890, p. 9; N. C. B. 73.*)

Cutting for hay must be done before the seed is matured or the quality deteriorates. From 1½ to 2 tons per acre is an average crop. In the South bent grasses produce a taller growth than in the North, yet they are hardly profitable as hay-producing grasses. Their chief value is for pasture, especially for dairy farming (*Me. R. 1889,*

p. 162; Minn. B. 12, R. 1888, p. 183; Miss. R. 1890, p. 30; Nebr. B. 6, B. 12. B. 17; Nev. R. 1890, p. 9). They will not do as grasses for rapid rotation of crops as they are two or more years in reaching their full value. They maintain themselves against any and all weeds and other grasses while getting started (*Minn. R. 1888, p. 183; Miss. R. 1890, p. 30*). They are easily and cheaply seeded and may be sown alone or with some other grass, as timothy (*Ky. R. 1888, pp. 18, 71*).

For a lawn Rhode Island bent grass is said to be better than Kentucky blue grass (*R. I. R. 1890, p. 156*).

Field tests and analyses of these grasses are given in *Colo. B. 12; Iowa B. 11; Ky. R. 1888, pp. 18, 71; Me. R. 1888, pp. 86, 95, R. 1889, p. 162; Mass. State R. 1888, p. 223, R. 1890, p. 291; N. C. B. 73; Ore. B. 11; Tenn. B. vol. II, 4, vol. IV, 1; W. Va. B. 19.* For analyses see also *O. E. S. B. 11.*

BERMUDA GRASS (*Cynodon dactylon*).—This is a perennial grass, probably a native of India, and introduced into this country in ballast from ships coming from southern Europe. It is a low, creeping plant, with abundant short leaves at the base and sends up a slender, nearly leafless stem bearing at its summit three to five slender, divergent spikes, on which, on two rows, are borne the flowers and seed. Its creeping root stocks run everywhere, and it soon forms a dense sod. It seeds very sparingly in the United States, hence it must be propagated from imported seed or by sowing or planting the chopped sections of the root stocks, which retain their vitality for a considerable time. It is not affected by heat or drought, but is very susceptible to hard frosts. On this account it is not of much value in the North, but south of the Ohio River it is one of the most valuable grasses. Its chief value is as a summer pasture, for it flourishes when all other grasses are parched and dead. Its low growth in this country is unfavorable for producing hay, yet some is produced of an exceedingly valuable composition. It is said under ordinary conditions to produce from 1 to 2 tons of hay per acre dependent upon the soil, and it has a theoretical feeding value of about $13 per ton. It will grow on almost any soil unless too wet, but does not do well in the shade. If cut two or three times each season it gives the best results (*Ala. College, B. 6; Ga. B. 7; Nev. R. 1890, p. 7; Miss. R. 1890, p. 30, B. 15; S. C. R. 1888, p. 123*). With fertilizers, as much as 10 tons of hay per acre have been cut during the season (*S. C. R. 1888, p. 123*). One of the greatest disadvantages of this grass is the difficulty with which it is eradicated. Its best use is as a permanent pasture, but if it is desirable to get rid of it, fall plowing, so as to expose roots to frost, and clean cultivation will usually succeed. If not, sowing some thickly growing crop, as Japan clover, will, by shading it, kill it out (*N. C. B. 73*). Where grass is sown to keep the soil from washing no species is better than Bermuda (*S. C. R. 1888, p. 124*).

Analyses are given in *Ala. College B. 6, n. ser.; Ga. B. 7; N. C. B. 73; O. E. S. B. 11; S. C. R. 1888, p. 123.*

KENTUCKY BLUE GRASS (*Poa pratensis*) [also known as June grass, Spear grass, and Meadow grass].—This grass is native and does well on almost any soil, but best upon clay soils overlying limestone. It is a perennial, a few inches to 2 feet high, with an abundance of long, narow, soft, root leaves. The panicle or head is pyramidal in outline. It spreads rapidly by means of numerous runners or suckers, forming a thick, compact sod. On this account it will stand pasturing, as the tramping of cattle does not kill it out. It is preëminently a pasture grass, forming the principal constituent of most permanent pastures of the Middle and Eastern States. It does not do so well for hay as some other grasses, since it does not produce enough stalks at a time to make it profitable. In seeding it, about 1 to 2½ bushels per acre are required. This is due to the low vitality of the seed offered in market. Hardly any of it shows a vitality of 20 per cent and most is perhaps below 10 per cent (*N. C. B. 73*). Three years are required from seeding to get a good set as it is of slow growth when starting. On this account it will not do for a rotation crop. When once established no care is needed for some time. Pastures of sixty years are known to be

still in good condition (*Minn. R. 1888, p. 171; Nebr. B. 12*). This grass does not succeed well in the far South but extends to high latitudes in the North (*Ala. Canebrake B. 9; Minn. R. 1888, p. 171; Miss. R. 1890, p. 32*).

For composition see *Appendix, Table I*. Analyses are also given in *Ill. B. 5; Ky. B. 5, R. 1888, p. 72; Mass. State R. 1890, p. 161; N. Y. State R. 1888, p. 338.*

TEXAS BLUE GRASS (*Poa arachnifera*).—This is closely related to the Kentucky blue grass, from which it differs mainly in its more vigorous growth. The seeds are different, those of this species being usually covered with long wool, causing them to adhere. It grows to a height of 2 or 3 feet, with a few long leaves on the stalk. An abundance of root leaves are produced, some attaining a length of 2 feet. It spreads by means of many underground runners, and will form a sod in a single season capable of withstanding any amount of pasturing. It is native of the southern part of the United States where it promises to become one of the best pasture grasses for fall and winter. It makes rapid growth as soon as rains come and withstands drought better than the Kentucky blue grass. It does well as far north as Kansas and in California and Oregon. (*Ala. Canebrake B. 9; Cal. R. 1890, p. 203; Fla. B. 6, B. 16; La. R. 1891, p. 13; Nev. R. 1890, p. 7; Ore. B. 4, B. 11; S. C. R. 1889, p. 146; Tenn. B. vol. IV, 1.*)

The habit of its seeds in matting together makes any sowing of this grass very difficult. Broadcast sowing nearly always fails (*Miss. R. 1890, p. 29*), but when planted in drills 1 foot or 18 inches apart it does well and it will cover the intervening grounds within a year. Another way is to plant in rows the chopped sections of the rootstocks. In either case it will care for itself, overcoming and crowding out all weeds and grasses. September or October is the proper month for such planting. It prefers a light, rich soil and not too much water. Its growth after fall rains often amounts to an inch per day. (*Ala. Canebrake B. 9; Fla. B. 16; Miss. R. 1890, p. 29; S. C. R. 1889, p. 146.*)

Analyses of this grass are given in *N. C. B. 73; Tenn. B. vol. IV, 1; O. E. S. B. 11; S. C. R. 1889, p. 146.*

BLUE JOINT (*Calamagrostis canadensis*).—This is a stout native perennial grass, growing chiefly in low, moist meadows, or wet, boggy ground. It prefers a cool climate and is often abundant in mountain meadows. The culms are from 3 to 5 feet high and are hollow. The leaves are numerous, a foot long, half an inch wide, and rough, while the sheaths and stems are smooth. It spreads from underground shoots and does not seed very abundantly. It makes good hay if cut early and is not much inferior to timothy. Analyses are given in *Iowa B. 11; Me. R. 1888, pp. 86, 94, R. 1889, p. 38.*

LARGE BLUE JOINT (*Andropogon provincialis*, or more properly *A. furcatus*).—This is a coarse perennial grass found along river bottoms and elsewhere, growing from 1 to 6 feet high. Its leaves are numerous, rough-margined, and somewhat hairy on the sheaths and margins. It usually bears at the summit of the stem three digitate or spreading flower spikes. When cut early it furnishes fairly good hay in considerable abundance (*Colo. B. 12; Iowa B. 11; W. Va. B. 19*). Another species (*A. scoparius*) is known as "little blue joint" or broom sedge. This differs from the other in being smaller and having scattered flower spikes. It grows on any soil, even the poorest sandy ones, and makes a fair quality of hay if cut early enough. Analyses are given in *Colo. B. 12; Iowa B. 11; W. Va. B. 19.*

BROME GRASSES (*Bromus* spp.).—Hungarian or awnless brome grass (*Bromus inermis*) is the principal forage grass of some parts of Hungary and is said to thrive on soil too poor to grow any other grass. It is a finer grass and more leafy than rescue grass and is said to be perennial; in other respects it resembles rescue grass very much. In parts of California it is said to be greatly preferred to any other grass. In some localities it has produced 4 tons of hay per acre in October from seed sown in February. It grows about 2 feet high. It is not altogether hardy in this country (*Cal. R. 1886, p. 90, R. 1890, p. 207; La. B. 19 2d ser*). It is considered one of the best grasses in Iowa (*B. 11*) and good reports are given of it in *N. C. B. 73*. Analyses are given in *Iowa B. 11* and *N. C. B. 73.*

Short-awned brome grass (*Bromus breviaristatus*) grows to a height of 2½ to 3 feet and is a hardy perennial, starting early and making rapid growth in spite of severe drought. It makes a heavy aftermath. An analysis gives it a high value as a forage grass (*Iowa B. 11*).

Other brome grasses are known as *Bromus ciliatus, B. kalmii, B. mexicana, B. mollis, B. secalinus, B. pratensis,* and *B. sterilis.* Of these, some may prove to be of value, some are worthless, and some are harmful, as *Bromus secalinus* and *B. racemosus,* the well-known cheat of the wheat field (see also *Rescue grass*).

BUFFALO GRASS (*Buchloë dactyloides*).—This is one of the most valuable grasses of the great plains. It is a low, spreading grass, seldom rising more than 5 or 6 inches above the ground. It grows in patches and spreads by runners, rooting at every joint, from which spring up individual plants. The plants are mostly diœcious, that is, having male and female flowers upon different individuals. Its low growth prevents its use save as a pasture or lawn grass. For this purpose it is said to be one of the best in the region in which it abounds. It is very nutritious, and is said to seed well, or to grow from cuttings of the runners. It is also said to respond to the conditions of cultivation, and would probably become a most valuable addition to the permanent pastures of the great plains. (*Ariz. B. 2; Colo. B. 12.*)

CANARY GRASS (*Phalaris arundinacea*) [also called Reed canary grass or Ribbon grass].—There is another species (*P. intermedia*) known as Southern reed canary grass, Gilbert's relief grass, or California timothy. The former is a native perennial, ranging through all the northern United States and Canada. The latter ranges throughout the Gulf States and across to California and Oregon. The Southern grass is said to be an annual or biennial, while the Northern is perennial and spreads by strong running roots. These grasses are from 1 to 5 or more feet high, and very leafy. The leaves are 6 to 10 inches long and ½ inch wide. The Northern species is eagerly eaten by stock, and after a crop of hay is cut a strong aftermath is sent up, making a good pasture (*Colo. B. 12; Iowa B. 11*). It prefers moist soil, but has been found high upon the mountains and abundant on the plains of Colorado (*B. 12*). Analyses of this grass are given in *Colo. B. 12; Iowa B. 11.* The garden ribbon grass is a variety of this grass in which the leaves are striped with white.

The Southern species is said to be of rapid growth, to make good hay, and to be a good winter and early spring forage grass. This grass is said to resemble meadow foxtail in its general appearance (*N. C. B. 73; Tex. R. 1888, p 30*).

CORD GRASS AND MARSH GRASS OR SALT GRASS (*Spartina cynosuroides* and *S. juncea*).—These grasses are coarse perennials, and, as their names indicate, are fond of wet situations. They grow 2 to 5 feet high, are rather leafy, and produce large quantities of hay. The hay is of inferior quality, and unless cut early will be refused by stock. The cord grass ranges from the Atlantic coast to the Rocky Mountains wherever sufficient moisture is to be found, as along rivers and irrigation canals. The other species is confined to salt marshes. They furnish the principal source of the so-called "prairie hay," used extensively in packing crockery, etc. (*Colo. B. 12; Conn. State R. 1889, p. 235; Iowa B. 11.*)

For analyses see *O. E. S. B. 11.*

CRAB GRASS (*Panicum sanguinale*).—This is an annual grass that springs up in many fields after the period of cultivating the crop is passed. It grows to a height of 2 or 3 feet, the stems are usually bent at the base, and the lower joints are often found rooting. At the top of the stalk are from three to twelve slender, spreading, purplish spikes, bearing the flowers and seed. In many places it is considered a nuisance in the fields, but in the South it has considerable value. It may be cut from between the rows of corn or cotton and a ton or more of hay of good quality per acre be secured. If a field of this grass be plowed and harrowed in June it will seed itself, and two or more crops of hay may be secured. It must be cured without much rain falling upon it while curing or the quality of the hay will be greatly impaired. (*Colo. B. 12; Miss. R. 1890, p. 30; Tenn. B. vol. IV, 1.*)

Analyses are given in *Fla. B. 11; Ga. B. 7; Miss. R. 1888, p. 33; Tenn. B. vol. IV, 1; O. E. S. B. 11,* showing it to be highly nutritive, and stock are said to eat it eagerly. It ranks close to Bermuda grass in value and the cheapness with which a crop may be secured makes it desirable in some places. It spreads by seed with great rapidity and is often very troublesome; but by keeping it from seeding it may be controlled (*N. C. B. 73; Miss. R. 1890, p. 30*).

MEADOW FESCUE (*Festuca elatior*), [also known as Tall fescue and Randall grass].—This grass is a native of the cooler parts of the Old World. It is a perennial, growing to a height of 2 or more feet, usually tufted or growing in clumps. The blades of the leaves are from 6 inches to 2 feet long and rather abundant. Its fibrous roots go deep into the soil and as a consequence it withstands drought very well. Stock of all kinds seem very fond of it both as grass and hay. They ield on average soil will be about 2 tons per acre. It is seeded without much trouble in any ordinarily moist soil, but does not attain its full development until the second and following years. In the upper districts of the South it grows all winter and is valuable for its pasture on this account (*Ill. B. 5; Iowa B. 11; Nev. R. 1890, p. 11; N. C. B. 73*). In some of the Northern States it has not been well received either on account of not yielding heavily, as in Iowa, or not standing the drought, as in Colorado (*Colo. B. 12, R. 1890, p. 180; Iowa B. 11*). It may be sown either in the spring or fall. Two bushels of seed per acre will be required. The seed looks somewhat like cheat and the panicle bears considerable resemblance to a slender panicle of cheat. A variety of meadow fescue is commonly recognized and called *Festuca pratensis.* Analyses of this grass are given in *Conn. Storrs B. 6; Ill. B. 5; Iowa B. 11; N. Y. State R. 1888, p. 242; N. C. B. 73.* (See also *Appendix, Table I.*)

SHEEP'S FESCUE (*Festuca ovina*).—This grass differs from the tall or meadow fescue only in its greatly reduced size, being one of the smallest grasses employed in agriculture. Its leaves are short and fine and the stalks seldom over a foot high. On this account it will not do for hay. It grows usually in scattered clumps and probably has little value except as a pasture grass. It does well upon rocky hillsides and upon poor soil where no other grass can secure a hold. It is hardy and persistent. Cattle are said to dislike it, but it is preferred by sheep. It is a native grass in Europe and the United States, where there are several forms. (*Minn. R. 1888, p. 176; Neb. B. 6, B. 12, B. 17; N. Y. State R. 1889, p. 217; N. C. B. 73.*) An analysis of the hay is given in *N. C. B. 73.*

There are other fescues, as hard fescue, red fescue, etc., which have more or less reputation as forage grasses, but most of them are but varieties of sheep's fescue and are similar to it in most of their attributes. About the only advantage they have over sheep's fescue is their greater size (*Colo. B. 12; Ill. B. 15; N. C. B. 73; Ore. B. 4*). For analyses see *O. E. S. B. 11.*

FOWL MEADOW GRASS (*Poa serotina*) [also called False redtop].—This grass is closely related to the Kentucky blue grass. It may be distinguished from that by the absence of running rootstocks. The culms are erect, 1 to 3 feet high. The leaves are narrow, about one-fourth inch wide and 3 to 6 inches long. The leaf sheaths are long, smooth, and striate. This grass is native in the northern and eastern part of the United States where it grows in river bottoms and moist situations with redtop, which it greatly resembles. It may be distinguished by the absence of running rootstocks and by a more dense panicle, which is long and nodding. It gets its name of fowl meadow grass from its supposed introduction near Dedham, Massachusetts, by water fowl. It is considered best as a pasture grass but is said to be valuable as hay. The stalks never become hard and on this account it may be cut at almost any time and there will be no waste (*Colo. B. 12; Mich. B. 77; Nev. R. 1890, p. 8; N. C. B. 73*). The best conditions as to soil and moisture for redtop apply to this grass as well. The seed is nearly always mixed with redtop seed and the seeds of weeds of moist meadows. Experimental tests and analyses are recorded in *Iowa B. 11; Mich. B. 77; N. Y. Cornell B. 15; N. C. B. 73.* (See also *O. E. S. B. 11.*)

Gama grass (*Tripsacum dactyloides*).—This native grass was formerly abundant in the South, where it was used as a forage plant. It flourishes best in wet places, where the culms attain a height of 4 to 6 feet. The leaves are broad and resemble blades of corn. It may be propagated by cuttings, but as it grows to advantage only in wet places will hardly pay for the trouble. The fodder it furnishes resembles that of corn and may be used in about the same way (*N. C. B. 73*). For analyses see *N. C. B. 73; O. E. S. B. 11.*

Gramma grass (*Bouteloua* spp.) [also called Mesquite grass].—The most common species of gramma grass are *Bouteloua oligostachya, B. racemosa,* and *B. hirsuta.* They are perennials, growing a foot or so high, with narrow, light-green leaves. *B. racemosa* has twenty or more small spikelets on one main spike while the other two have one to five spikelets about an inch long, purplish in color, and in the case of *B. hirsuta* very hairy. These grasses are of great importance upon the Western ranges, as they supply quite a portion of the forage. They grow in clumps and cure into good hay while standing. They are rather abundant and seem to respond to cultivation. Their growing in bunches may be against them as hay crops, but they are excellent as forage. The grass is tender and sweet and stock eat it with great eagerness. It is largely upon gramma grasses that stock is expected to winter upon the Western range and it is here that its self-curing habit is of great advantage. (*Ariz. B. 2; Colo. B. 12; Nebr. B. 6, B. 12, B. 17.*)

Hungarian grass.—See *Millet.*

Johnson grass (*Sorghum halepense*) [also known as Mean's grass].—This grass is a native of North Africa and was brought to South Carolina about 1830 by Governor Means. About ten years later it was introduced into Alabama by Capt. William Johnson. By its friends this grass is considered of great value where other grasses are affected by drought. By its enemies it is considered an unmitigated nuisance. It is a rank, rapidly growing perennial, attaining a height of 4 to 6 feet or more. It bears a large number of long leaves and a head slightly resembling the broom corn, although less compact. It seeds freely and spreads by underground root stocks. On this account it is not easily eradicated. It does not stand frost and as a result is confined to warm climates. The seed may be sown at any time when not too dry and the richer the land the better will be the crop. One to 2 bushels of seed per acre will be needed and for hay the thicker the sowing the better. Two or three crops of 2 or 3 tons each per acre may be secured and stock, especially cattle, are said to be very fond of it. Johnson grass should be cut just as the heads are beginning to show. If left later the stalks become woody and hard (*Miss. R. 1890, p. 30; Nebr. B. 12; N. C. B. 73; Tex. B. 20*). If after sowing the plants are not thick enough, running through with a disk harrow or tearing up the root stocks in any way will increase the stand. If it is desired to get rid of it considerable difficulty will be experienced. Plowing several times in midsummer and clean cultivation will usually eradicate it (*Ga. B. 7; N. C. B. 73; Tex. R. 1888, p. 17*). The straggling bunches left from the plowing may be killed by covering with salt or bleaching powder, chloride of lime (*Md. R. 1888, p. 68; Miss. R. 1890, p. 30; Tex. B. 20*). Close pasturing if continued for a considerable time will also kill it. It is spread by seed to places where it is not wanted. If cut at the time mentioned no seed will be matured. For a permanent meadow in the South it is good, but if the meadow is not to remain, some other grass will give less trouble. In Nebraska it is grown as an annual from Southern seed with considerable success. In Oregon, California, and Nevada it is thought to be of doubtful value (*Cal. R. 1890, p. 211; Nev. R. 1890, p. 7; Ore. B. 4*). The hay is said to be equal or superior to timothy (*Ga. B. 7; Md. R. 1888, p. 68; N. C. B. 73; Tex. B. 20.*) For analyses of grass and hay see *O. E. S. B. 11.*

Louisiana grass (*Paspalum platycaule*), [also called Carpet grass, or Blanket grass].—This is a low, creeping perennial grass, supposed to be native in the Southern States. It has flat stems that trail along the ground, rooting at every joint. It is of little value except for pasture, since it lies too close to the ground for the mower.

It will crowd out all other grasses and weeds. It will grow on almost any soil, stands drought well, is not affected by frosts, and is evergreen, making it a good pasture grass for winter and summer. It starts slowly from seed, but spreads rapidly, a single plant covering 10 to 20 square feet in a season. It forms a dense sod and will stand more pasturing than any other grass. It is nearly equal to Bermuda grass in feeding value and is not difficult to eradicate. Ordinary cultivation will clear the ground of it in a single season. All reports from the regions in which this grass grows are favorable to it (*Fla. B. 11; Miss. R. 1890, p. 28; N. C. B. 73; Tex. R. 1888, p. 41*).

MEADOW FOXTAIL (*Alopecurus pratensis*).—This is a strong perennial creeping grass, a native of Europe. It greatly resembles timothy and flourishes wherever that grass is found. It may be distinguished from timothy by its shorter, thicker, and softer spike, also by the sheaths of the leaves, especially the upper ones, being considerably inflated about the stalk. It is said to soon die out on thin soil, but on rich soils will grow to a height of 2 or 3 feet and yield a ton of hay per acre for three or four cuttings each season. Its chief value is as an early spring grass. It is said to give pasture a week or more earlier than any other grass. It forms a thick sod and withstands drought fairly well. It is widely recommended as a constituent of permanent meadows on account of its nutritious substance and early development. In the South it will not stand the heat (*Miss. R. 1890, p. 33*). It is difficult to obtain pure seed of this grass, the seed being mixed with others of inferior value. (*Miss. R. 1890, p. 33; Nebr. B. 6; Nev. R. 1890, p. 7; N. Y. State R. 1888, p. 237, R. 1889, p. 46; N. C. B. 73; Ore. B. 4.*) For analyses see *O. E. S. B. 11.*

MEADOW GRASSES (*Poa* spp.)—Under this name are included many of the native and also some introduced species of *Poa* as *P. annua*, *P. tenuifolia*, *P. nemoralis*, etc. English blue grass, wire grass (*Poa compressa*), and rough-stalked meadow grass (*P. trivialis*) are sometimes called simply meadow grass. They are all related to the Kentucky blue grass and greatly resemble it. They make good sod and fair pasture, but are mostly of too short growth for hay. They are all rather hardy and may add something to the value of pasture, especially where they grow naturally, but are not equal to the Kentucky blue grass in amount or value of forage. (*Cal. R. 1890, p. 251; Colo. B. 12; Ill. B. 15; Minn. B. 12; Nebr. B. 6; Nev. R. 1890, p. 8; N. Y. Cornell B. 15; N. C. B. 73; Ore. B 4.*)

ORCHARD GRASS (*Dactylis glomerata*).—This is a rank-growing perennial that holds a high place wherever tried. In Europe it is considered one of the best pasture grasses, and wherever it has been introduced in this country it has met with favorable mention. The root leaves are numerous. The stem is from 1 to 4 feet high, bearing five or six leaves. The leaves and stalks are rough. The flowers are borne in short, compact clusters, on rough pedicles. This grass grows in almost any rich soil where there is not too much moisture, and will yield from 1 to 3 tons of superior hay per acre. It grows rapidly, and will, under favorable conditions, give two to four crops per year. For hay it must be cut when in bloom or earlier as it soon becomes too woody (*Ky. R. 1888, p. 18; N. C. B. 73*). This grass seems to flourish in all parts of the United States and everywhere furnishes the earliest and latest pasture. Its tendency to grow in clumps or bunches is somewhat against it, but this may be remedied, to a degree, by seeding closely or mixing some other seed. Blue grass and redtop crowd it out. As a crop for rotation it will hardly pay, owing to the cost of seed and amount required, but for permanent pasture it has few equals. It withstands drought well, does not exhaust the soil as much as timothy, and after cutting or pasturing its growth is very rapid. The seed may be sown in fall or spring and will give pasture in a year and bloom in two years (*Ala. Canebrake B. 9; Minn. R 1888, p. 168*). In some places the old grass is burned off in the spring, but this practice is to be condemned (*Minn. R. 1888, p. 168*). (*Ala. Canebrake B. 9; Iowa B. 11; La. B. 8, 2d ser. R. 1891, p. 12; Minn. R. 1888, p. 168, B. 12; Miss. R. 1890, p. 27; Nebr. B. 12; Nev. R. 1890, p. 9; N. C. B. 73; Ore. B. 4, B. 11; Tex. B. 8; W. Va. B. 19.*)

Tests of seed show in seventeen cases the average vitality of seed to be but 40 per cent. Many samples contain cheaper and inferior seeds, in varying proportion (*Conn. State B. 108*).

Analyses of orchard grass as grass and hay and as to its digestibility are given in *Ky. R. 1888, p. 18, B. 5; Me. R. 1888, pp. 86, 94; N. Y. State R. 1888, p. 240; N. C. B. 73; S. C. R. 1889, p. 116; Tenn. B. vol. II, 4, B. vol. IV, 1; Vt. R. 1889, p. 85.* (See also *Appendix, Table I.*)

PERENNIAL RYE GRASS (*Lolium perenne*) [also known as Ray grass or Darnel].—In Europe this grass holds about the same position that timothy does in the United States. It is a strong, rapid grower, and forms a thick sod. In England, meadows of this grass have existed for many years without reseeding, but in this country the plant varies from an annual in the North to a perennial in the South, although it seems to run out after six or eight years. A strong, rich clay soil, without too much moisture, is best adapted to its needs. It grows to a height of 2 feet or more and bears an abundance of flat leaves. The spikelets are flat and are placed edgewise, alternating on either side of the stem, giving the rhachis a zigzag appearance. It must be kept cut or grazed rather close or the mat will keep the ground so moist as to cause the roots to rot. It will produce about 2 tons of hay per acre and give an abundant aftermath for pasturing. It seems to do well in the warmer parts of the United States, but in the North it is almost always winterkilled. (*Colo. B. 12, R. 1890, p. 171; La. R. 1891, p. 13; N. C. B. 73.*) In Nevada and Oregon it promises well, as it stands drought and is well adapted to irrigation (*Nev. R. 1890, p. 10; Ore. B. 4 B. 11*). In Massachusetts and New York it is nearly always winterkilled, while it seems semi-hardy in Nebraska and Minnesota. (*Mass. R. 1890, p. 291; Minn. R. 1888, p. 174; Nebr. B. 6.*)

In many places, especially in the South, this grass enters into nearly every mixture for a temporary and permanent meadow. It seeds abundantly and is cheap. As a pasture grass for dairy stock it has no superior, giving as it does a peculiarly fine flavor to butter and cheese.

ITALIAN RYE GRASS (*Lolium italicum*).—This is an annual, or biennial in most parts of our country, and gives better satisfaction than the perennial rye grass. It is only hardy in the Southern States, where it has been well received. It is claimed as a superior grass upon irrigated meadows. If sown in the fall five or six cuttings of from 2 to 3 tons per acre may be had the next season. In general appearance and value it differs but little from the first species. The most striking difference is that the Italian rye grass has barbs or bristles, while the other has none. The seed of the perennial rye grass is frequently substituted for that of the other species. (*Ill. B. 15; La. R. 1891, p. 13; Nev. R. 1890, p. 10; N. C. B. 73.*)

Analyses are given in *Colo. R. 1890, p. 171, B. 12; N. C. B. 73; O. E .S. B. 11.*

RESCUE GRASS (*Bromus unioloides*) [also called Schrader's grass].—This is an annual of considerable promise in several parts of the United States. In the South it is one of the so-called winter grasses. If sown in the fall, by February a crop of hay may be cut from it. It is an erect, smooth-stemmed plant, growing 2 or 3 feet high. The leaves are flat, linear, slightly roughened on both sides, and rather abundant. The spikelets are flat and rather numerous in the panicle. It resembles the well-known, "cheat" or "chess" to which it is closely related. In warm climates it tends to become perennial. It must not be cut or pastured after April, but left to seed itself. In this way it may be propagated from year to year. (*Cal. R. 1890, p. 204; Miss. R. 1890, p. 27; N. C. B. 73; Tex. R. 1888, p. 42, B. 20*). In colder climates it must be sown in the spring and it will remain green until late in the fall, having given several cuttings of hay averaging 2½ tons per acre during the season (*Colo. B. 12; Nebr. B. 6*). It stands drought very well and will grow on almost any kind of soil, although preferring a moist, rich soil. The hay is very nutritious (*N. C. B. 73*). If properly treated it is said to be one of the most valuable grasses introduced into cultivation, excelling rye or

oats as winter forage. Provisions for self-seeding must be made every year or it will run out in a season or two (*Cal. R. 1886, p. 85, R. 1890, p. 204; Miss. R. 1890, p. 27; Tex. R. 1888, p. 12*). This grass has been placed on the market under the name of Australian oats and *Bromus schraderi.* Analyses are given in *N. C. B. 73; Tex. B. 20; O. E. S. B. 11.*

SWEET VERNAL GRASS (*Anthoxanthum odoratum*).—This is a low, sweet-smelling perennial, a native of Europe, seldom exceeding a foot in height. It will grow on any kind of soil, even the poorest. On this account it is sometimes called poverty grass. It is used principally in mixtures for pastures and lawns. It is too short to be of value for hay. Wherever tried in this country it grows, but usually does not make a sufficient stand if used alone. It grows well in the shade and might be employed where other grasses would not grow. In rich soil it is easily run out by other grasses. (*Ill. B. 15; La. R. 1891, p. 12; Nev. R. 1890, p. 7; N. C. B. 73; O. E. S. B. 11.*)

TALL MEADOW OAT GRASS (*Arrhenatherum avenaceum*).—This is a native of the Old World, where it is highly prized. It is a perennial, growing from 2 to 4 feet or more high and is rather leafy, the leaves being 6 to 10 inches long and a quarter of an inch wide. The flowers and seed resemble the cultivated oats. It is a strong, rapid grower, and does best on loose, light soils, where the roots penetrate to a considerable depth. On this account it withstands drought and freezing remarkably well (*Iowa B. 11; Minn. R. 1888, p. 175, B. 12; N. C. B. 73*). It seems better for a pasture grass than for hay. The hay is of second-rate quality, owing to a decided bitterness, but stock will eat it without much difficulty. It will provide two or three cuttings of 2 to 5 tons per acre, depending on the latitude. It must be cut in bloom or before as it gets woody in a short time after blooming. The hay is regarded as inferior to timothy and orchard grass. (*Ala. College B. 6, n. ser.; Cal. B. 1890, p. 208; Iowa B. 11; Ore. B. 4, B. 11*). Two to 3 bushels per acre of seed are required, and September or October is the best time for sowing (*Ala. B. 6, n. ser.; N. C. B. 73*). In Oregon and the Pacific slope generally later sowing will do. When sown in February it will be ready in May to cut for hay (*Ore. B. 4*). It is said to do best when used with other grasses. It spreads over the ground better than orchard grass, but like it stools out, not making a thick sod. Analyses may be found in *Ala. B. 6, n. ser.; Iowa B. 11; N. C. B. 73.* (See *Appendix Table 1.*)

TERRELL GRASS (*Elymus virginicus*) [also known as Wild rye grass from the resemblance it bears to rye].—This is a native perennial which abounds in nearly all marshes and along stream banks. It will grow on dry land, but will not stand much pasturing during the summer. In the South it is thought to be a very promising grass for winter and spring pasture. All stock eat it readily as a grass, but the hay is said to be rather poor. It is of rapid growth, and if sown in September will be fine pasture in two months. With proper attention it will no doubt prove of considable value (*Miss. R. 1890, p. 29*).

There are other species of *Elymus* known as rye grasses, the principal of which is *E. canadensis.* It is of little value except when young. Analyses are given in *Colo. B. 12; Iowa B. 11; O. E. S. B. 11.*

TIMOTHY (*Phleum pratense*) [also called Herd's grass in New England and New York].—This is one of the most common grasses grown for forage. It is a perennial, growing from 1 to 3 feet in height, and is indigenous to the cooler parts of North America, Europe, and Asia, where it flourishes best in moist, heavy soils. Its roots are usually fibrous, but often bulbous, and as it spreads by "stooling" it never forms a heavy sod. On this account it does not stand pasturing very well, the tramping of stock killing it out. It is easily and cheaply seeded and forms a good crop the second year after sowing. The yield is from 1 to 3½ tons per acre. Where it is grown extensively for hay it should be cut just before the seed becomes mature, as at that time the per cent of total digestible constituents and the yield is the greatest. If cut earlier while in bloom or before, some of the food elements will be higher and the actual value greater, but the total quantity will be much less than from late cutting (*N. H. R. 1889, p. 69; N. C. B. 73*). In Iowa tests showed that seeding between

March 23 and April 13 give best results (*Iowa B. 15*). In Alabama, Arkansas, Colorado, and Mississippi it does not do very well, being a total failure in the first and in part in the other States (*Ala. Canebrake B. 9; Ark. R. 1890, p. 129; Colo. R. 1889, p. 96, 124; Miss. R. 1890, p. 32*). It prefers heavy soil and does not stand drought very well. A meadow of timothy alone will last but five or six years. It is said to impoverish the land to a great degree. The amount of stubble and roots available as fertilizers on an acre is about 650 pounds, being considerably less than for several other grasses (*Conn. Storrs R. 1889, p. 69*). In many regions the practice of sowing timothy with some other grass is followed with good results. Various combinations are suggested. In the South redtop or some similar grass is recommended (*N. C. B. 73*); in the West alsike clover (*Ore. B. 4, B. 11*); while red clover is commonly added to it in many places. The only objection to mixing seed is the probability of securing differences in maturity that may influence the value of the crop. Analyses may be found in *Ga. B. 7; Ky. B. 5; Me. R. 1888, pp. 86, 95, R. 1891, p. 34; N. H. R. 1889, p. 46; N. J. R. 1889, p. 169; N. Y. State R. 1890, p. 56; N. C. B. 73; S. C. R. 1889, p. 116.* (See also, *Appendix Tables I* and *II.*)

VELVET GRASS (*Holcus lanatus*) [also called Velvet mesquite grass].—This is a perennial grass introduced from Europe and now well established in various parts of this country. It grows from 6 inches to 2 feet high, with short, broad leaves. The whole plant has a soft, velvety character, due to its covering of minute hairs, giving it a grayish color. It prefers moist, rich soil, and its tendency to grow in bunches is rather against it. In Colorado (*B. 12*) it did not succeed very well. It is not very nutritious and opinions differ as to whether or not stock like to eat it. It is early and produces considerable forage. (*Colo. R. 1890, p. 159; Nev. R. 1890, p. 7; Ore. B. 4; Tenn. B. vol. IV, 1; W. Va. B. 19.*)

WATER GRASS (*Paspalum dilitatum*).—This is a perennial grass native to the Gulf States, which promises well. It grows to a height of 5 feet, with numerous leaves a half inch in width. It stands drought well and is almost evergreen, being affected only by severe cold. Although its name suggests its growing in wet places, it flourishes in any kind of soil and is valuable either for pasture or hay. It is said to improve under grazing and tramping. It can be recommended as worthy of trial south of Tennessee. It grows from seeds or cuttings of roots, and when once established lasts indefinitely. It is not difficult to control if a change of crop is desirable (*Miss. R. 1890, p. 28*).

WHEAT GRASS (*Agropyrum glaucum*) [also known as Blue stem].—This grass prevails upon the plains from Texas to Montana, where it is highly prized by stockmen. It has rather stiff, erect stems and leaves by which it may be distinguished from couch grass. The leaves are often rolled in from the edges and the whole plant is of a bluish-green color. It is closely related to the couch grass of the Eastern States, which is usually considered a great nuisance. In the West the blue stem is considered one of the best native grasses for hay. The yield is not very abundant, but the quality is unsurpassed. It seldom grows very thickly upon the ground unless it be in moist places. In cultivation it spreads by runners with considerable rapidity. The plants attain a height of 2 to 4 feet and it promises quite well in some regions. In Iowa it is said to rust badly in some seasons. Analyses are given in *Iowa B. 11*. On the whole this grass probably deserves more extended investigation than has been given it (*Colo. B. 12; Iowa B. 11; Nebr. B. 6, B. 17; Wyo. B. 1*).

WILD OAT GRASSES (*Avena* spp.).—The principal species are *A. fatua, A. elatior,* and *A. flavescens.* These grasses are all closely related to the cultivated oat plant and may be easily recognized by their resemblance to it. They usually have more flowers than are found in the cultivated oats and in some species have a rather long, sharp awn, lacking in others. They are usually considered of little value and when once established in wheat fields they are quite pernicious. They make a fair quality of hay if cut before they are ripe and have some repute as pasture forage. (*Cal. R. 1890, p. 251; N. Y. State R. 1888, p. 338, R. 1889, p. 217.*)

WILD RICE (*Zizania aquatica*).—This is an aquatic plant or at least one liking plenty of moisture. It often grows in the water or along its edge, attaining a height of 5 to 10 feet. It bears an abundance of broad, flat leaves, which are said to be eagerly sought after by cattle and to be very nutritious. It bears a great abundance of very rich seeds which are said to be gathered by the Indians in the Northwest and used as rice. Birds of all kinds are fond of them. The habit of the grass will probably prevent its cultivation (*Conn. State R. 1889, p. 236*).

GRASSES OF MINOR IMPORTANCE.—The following species deserve mention:

Crested dogtail (*Cynosurus cristatus*) is a rather low-growing grass, which gives promise as a valuable pasture grass (*Minn. B. 12; N. C. B. 73*).

A foreign rye grass (*Lolium pacyii*) has been introduced into New York and promises as well as any of the rye grasses (*N. Y. State R. 1889, p. 218*).

Panicled blue joint (*Chrysopogon nutans*) is a promising grass for prairie hay but not for pasture. It runs into a number of forms and varieties, differing in color and abundance of seed produced. This grass will not stand cutting or pasturing in June or July. Analyses of the grass are given in *Iowa B. 11; O. E. S. B. 11.*

Crab grass, crawfoot, and yard grass (*Eleusine indica*) are names given to a very common grass in the South. It grows luxuriantly in any rich soil, usually around dwellings. It grows in rather thick tufts and is somewhat spreading on the ground. The culm is about a foot high and is terminated by five or more slender radiating spikes. It is an annual but seeds so rapidly after once started as to require no further attention. Most stock seem fond of it green and if care be taken a fair quality of hay can be made from it. Analyses are given in *Ala. College B. 6, n. ser.; O. E. S. B. 11.*

Tennessee or mountain oat grass (*Danthonia compressa*) is a rather promising native grass for pasture in the mountains and other places where the soil is light. A full description and analysis of this grass is given in *Tenn. B. vol. II, 4.* See also *O. E. S. B. 11.*

Chloris verticillata is a grass which has been introduced into Texas and is well thought of wherever it has been tried. It is a creeping grass, the culms growing only 5 or 6 inches high. It greatly resembles Bermuda grass and is preferred to it by some. The spikes are more numerous and longer than in the Bermuda, making it easy to distinguish them. It has a peculiar bluish-green color, seeds freely, and once started will take care of itself. (*Tex. B. 8.*)

Muhlenberg grasses (*Muhlenbergia glomerata* and *M. mexicana*) are receiving considerable attention in Colorado. They are native species and promise well under cultivation. They grow abundantly along streams in woods and meadows as well as in drier situations. The hay and forage furnished is of superior quality and is relished by stock (*Colo. B. 6, B. 12*). For analyses see *O. E. S. B. 11.*

There are a number of species of the genus *Panicum* that have more or less repute as forage grasses under the common name of panic grass. The principal ones are mentioned in *Ala. B. 6, n. ser.; Colo. B. 12; Mass. Hatch. B. 7; N. C. B. 73.*

There are several kinds of marsh grass that have more than local reputation. Among the more common ones are black grass (*Juncus gerardi*), creek sedge or creek grass (*Spartina stricta*), spike grass (*Distichlis maritima*), goose grass or greasy bog grass (*Triglochin maritimum*), three-square grass (*Scirpus* species), snipsnap or two-tail grass (*Eleocharis rostellata*), and furze or fine-top (*Agrostis vulgaris* var. *minor*). Descriptions and tabulated analyses of most of these are to be found in *Conn. State R. 1889, p. 233.*

Analyses of the following grasses are given in *Fla. B. 11:* Wire grass (*Aristida purpurea*), sandspur grass (*Cenchrus tribuloides*), and bull grass (*Eleusine indica*). They are of little value as forage plants.

The following are promising pasture grasses in Colorado: *Orysopsis cuspidata, Festuca scabrella, Elymus sibericus, Agropyrum divergum,* and *A. violaceum.* As grasses for dry forage the following: *Poa tenuifolia, Sporobolus depauperatus, Calamagrostis*

(Deyeuxia) stricta, C. canadensis, and *Hilaria jamesii.* Grasses well adapted to the high plains of Colorado are: *Elymus sibericus, Agropyrum divergens, Hilaria jamesii, Festuca scabrella, Orysopsis cuspidata, Koeleria cristata, Sporobolus arioides, Muhlenbergia gracilis,* and *M. wrightii.* (*Colo. B. 12.*)

Grasshoppers.—See *Locusts.*

Greasewood (*Sarcobatus vermiculatus*).—A much-branched spiny shrub of the goosefoot family, abounding in California. A sample of its dry brush was analyzed at the California Station (*B. 94*) to determine whether the plant was available for use as a fertilizer.

The ash was found to contain 18 per cent of potash and 3½ per cent of phosphoric acid, but the other ingredients were such as to amount to 72 pounds to the hundred of alkali, having the usual composition of "black alkali." This would be a disadvantage which would hardly be outweighed by the presence of potash, as this element is usually abundant in the soils where greasewood grows. The question is raised whether in clearing greasewood land it would not be an advantage to remove the brush. It is shown that if the greasewood stood thick enough to make 10 tons per acre a quarter of a ton of alkali would be removed in the brush, not an insignificant amount in soils liable to injury from excess of salts.

Greenhouses.—The greenhouses of the stations have to some extent been so built and equipped as to test different methods of construction, heating, etc. General illustrated descriptions of such buildings may be found in *Mich. B. 63; Minn. R. 1888, 209, B. 7; N. Y. Cornell R. 1890, p. 45, B. 25, B. 28, B. 31.*

At the Minnesota Station seven different methods of wall construction were tested. Isolated sections were built on the following plans: Two 4-inch walls of brick, having between them a 3-inch hollow tile; on each side of this a 1-inch air space; a solid brick wall 13 inches thick; two 4-inch brick walls with an air space of 5 inches between; a hollow wooden wall 3 inches thick, with a course of bricks and a 1-inch air space on each side; a wall of 4-inch studding, covered on the outside with matched boards, building paper, and clapboards, like the last, but boarded up also inside; same, but filled with sawdust. Boxes were placed against each section, containing thermometers, of which readings were taken three times daily. Among the conclusions were: The walls with more than one air space were warmer than the lined board wall filled with sawdust, but the latter is as warm as the brick wall with one air space. Of the brick walls, the warmest was that made of brick and hollow tile.

The wooden wall with brick veneer was warmer than the brick with a 5-inch air space; the last was nearly as warm as the 13-inch solid wall. Of the walls made of wood the warmest was that lined inside the studding and filled with sawdust. This inside sheathing is deemed a matter of great importance, and is recommended for stables as well as greenhouses and dwellings. "Probably the cheapest warm wall for general farm purposes is one made of wood with a 4-inch air space which is filled with dry sawdust or some other good nonconducting material."

A similar trial of four methods of structure reported in *Mass. Hatch B. 4* led to the following conclusions: (1) "That on the inside of the wall, the lined board walls, filled with shavings, give the best results, that with the hollow space being little less valuable; (2) that hollow brick and concrete walls are about equally valuable in protecting from cold, but not equal to the framed board walls."

In the description of the Michigan Station greenhouse (*B. 63*) it is stated that "Experiments have shown that a properly built wooden wall is warmer and more lasting than one of stone, brick, or cement, as ordinarily built. A wooden wall, however, is more or less subject to rot, and any portion below ground will need repairing in from five to ten years. In planning the new forcing house it was determined to have the side and end walls of cement below ground, where it would not be injured by frost, and of wood above the surface." The manner in which the plan was carried out is described and figured.

In *Mass. Hatch B. 4* a glazing experiment is reported in which "Glasser's patent zinc joints" were tested. These consist of strips of zinc so folded that the upper edge rests on the pane below and the other supports the edge of the pane above.

It is concluded in favor of these joints that by their use there is a saving in glass, the glass is more easily laid, less putty is needed, the frost gets under the glass less readily than when it is lapped, the glass does not slip down if the lower light is well fixed, no air can penetrate between the joints, there is no increase of drip. The same is favorably considered in *Mich. B. 63* except for the one drawback that some light is shut out, amounting to 3 per cent when the panes are 10 inches long.

The plan here preferred was to butt the panes together with a thin layer of putty between the edges. This gave a perfectly light roof which was not secured where the glass was lapped. Some notes are also made on putty bulbs, puttyless glazing, and glazing points. Several kinds of glazier's points are also mentioned in *Minn. R. 1888, p. 216*. In *Mich. B. 63*, the subject of ventilators and ventilating machines is discussed and illustrated.

Heating apparatus and methods have been the subject of experiment and discussion. A hot-water apparatus "piped on the down-hill plan" was used at the Minnesota Station and is described. At the Massachusetts Hatch Station (*B. 4, B. 6, B. 8*), careful tests were made during two seasons of the economy of steam as compared with hot-water heating. The second season the steam boiler consumed from December 1 to March 18, 9,784 pounds of coal to 6,598 pounds consumed by the hot-water heater, the latter maintaining at the same time a higher degree of heat. The results were similar the previous season. At the New York Cornell Station (*B. 41*) in a greenhouse where many elbows and fittings in the piping were required and the fall was slight, steam heating was found to be "more economical than hot water and more satisfactory in every way."

In *Mass. Hatch B. 15* the effects of the overbench and underbench methods of piping are compared. Though the temperature of the water was 4.81° higher where the pipes were over the benches, yet the house temperature was only ¼° higher, while considerably more coal was consumed. The effect upon the growth of plants was decidedly in favor of the underbench piping. The distribution of heat also was more uniform. The circulation of the water was not so regular under as over the bench, but it was judged that this might be remedied in a measure by setting the boiler lower.

As stated in *N. Y. Cornell B. 25*, in one case where the benches in the forcing houses were built over the pipes the lack of the bottom heat delayed a crop of beans four weeks.

Green manuring.—The practice of plowing down green crops to enrich the soil is a very old one, and the universal experience has been that it is a safe, sure, and economical method of increasing the fertility of soils in temperate regions (*Ala. Canebrake B. 10; Ala. College B. 16*).

This fact has been strongly brought out in experiments on the jack-pine plains of Michigan (*Mich. B. 68*). In 1888 experiments were undertaken looking to the renovation of the light, sandy, almost barren soils of these plains. The main reliance was on green manures, supplemented with cheap fertilizers. In three years marked improvement was evident, not only in the physical character of the soil, but in increased yields of various crops.

Two classes of plants are used for green manuring, those which are capable of thriving on a limited supply of plant food in the surface soil, which is thus saved from loss by washing or drainage, and those which gather plant food both from the air and subsoil and store it up in the surface soil. To the first class belong rye, buckwheat, rape, etc.; to the second the legumes—clovers, peas, vetches, etc.

The advantages of green manuring are an increase of the available plant food of the soil, not only from the stores gathered from the air and soil, but from that set free by the decomposition of the green matter in the soil; and an improvement of

the mechanical condition of the soil by the humus formed. The latter renders loose soils more retentive and tends to open up heavy soils.

The plants peculiarly adapted to green manuring are the legumes. This fact has been demonstrated by investigations commenced at the station at Middletown, Connecticut (*R. Conn. State Bd. of Agr., 1878, p. 335*) and continued for a number of years at the Connecticut Storrs Station (*B. 3, B. 5, B. 6, R. 1888, p. 28 R. 1889, p. 67 R. 1890, p. 12 R. 1891, p. 17*). In these investigations the manurial value of the crop, and root and stubble of various grasses, cereals, and legumes was determined, showing the vast superiority of the legumes over other farm plants as nitrogen gatherers, the grasses standing second, and the cereals third. It appears further from these experiments that the legumes are capable of assimilating the free nitrogen of the air by means of their root tubercles, and thus draw on a store of nitrogen not available to other plants.

In addition to this the leguminous plants as a rule have root systems extending over a wide area and to a great depth into the subsoil (*Minn. R. 1888, p. 188; N. C. B. 60*), and are thus able to draw upon soil supplies beyond the reach of other crops. So much of this fertilizing material is accumulated in these roots that even though the entire crop above ground be removed the surface soil will be permanently enriched by the stubble and roots (*Ala. Canebrake B. 10; Ala. College B. 16; Conn. Storrs R. 1888, p. 41*).

The cowpea (*Dolichos sinensis*) is widely used as a green manure in the Southern States. Experiments at the Louisiana Stations (*B. 20, B. 28*) show that 1 acre of cowpeas, yielding 3,970.38 pounds of organic matter, turned under, gave to the soil 64.95 pounds of nitrogen, 20.39 pounds of phosphoric acid, and 110.56 pounds of potash, of which at least 8.34 pounds of nitrogen, 4.43 pounds of phosphoric acid, and 18.1 pounds of potash were furnished by the roots. Analyses made at the South Carolina Station (*R. 1888, p. 127*) show that cowpea hay contains 1.42 per cent of potash, 0.39 per cent of phosphoric acid, and 2.71 per cent of nitrogen; cowpea roots contain 1.19 per cent of potash, 0.28 per cent of phosphoric acid, and 0.94 per cent of nitrogen; roots and stubble two months after crop was harvested contained 0.83 per cent of potash, 0.26 per cent of phosphoric acid, and 1.35 per cent of nitrogen. Experiments at the Alabama College Station (*B. 14.*) showed that the vines from a given area weighed six times as much as the roots and were 8½ times as valuable as manure.

The following table summarizes the results of four experiments in this line:

Fertilizing constituents per acre in cowpea vines, roots, and stubble.

	Vines.	Roots and stubble.	Vines.	Roots and stubble.	Vines.	Roots and stubble.	Vines.	Roots and stubble.
Estimated weights, per acre, pounds	2,236	713	13,128	1,916	5,558	1,054	6,612	862
Valuable fertilizing ingredients in 1 acre, estimated:								
Phosphoric acid....pounds..	23.03	7.77	73.51	10.72	30.56	6.53	29.09	2.58
Potash....do....	27.72	8.34	164.10	21.26	74.10	13.06	89.26	9.82
Nitrogen....do....	58.58	7.77	227.11	14.37	80.59	5.69	95.87	3.10

Similar results were obtained at the North Carolina Station (*R. 1886, p. 77*).

Cowpeas and melilotus have given good results as green manures on the canebrake lands of Alabama. "Before the land was sowed in melilotus and peas it was not considered worth cultivating. This season (1890) it produced as fine a crop as the best lands of the station highly fertilized." As regards the relative merits of these two plants for green manuring, it is stated that "pea vines will produce better results in one year, for they make more forage and cover the ground better. Melilotus makes a better crop the second year, and after it dies the land is more easily prepared." (*Ala. Canebrake B. 10.*)

As regards the best disposition to be made of the crop of pea vines results are conflicting. The Louisiana Station (*B. 28*) concludes from three years' experiments that it is more economical to turn the vines under as green manure than to harvest for hay; on the other hand, extensive experiments at Alabama Canebrake Station (*B. 10*) indicate that "the increased yield by leaving the stalks and vines on the land will not pay for the loss of hay." Six years' experiments at the Alabama College Station (*B. 16*) indicate that "pea vines cut for hay, leaving the stubble and roots on the land, benefit the soil more than turning them in green during the summer. They pay best when left upon the surface till the land is needed for another crop."

Analyses made at the same station show that "pea vines lose a large percentage of their nitrogen when left on the ground during the fall and winter months (*B. 14*), but whether this nitrogen is largely washed into the soil or escapes into the air is not made clear.

The value of alfalfa as a green manure has been quite thoroughly studied by the New Jersey Station (*R. 1889, p. 159*). It appears from these investigations that this plant derives nitrogen from some other source than the soil and draws potash through its long roots from the deeper layers of the subsoil. The value of this plant as a manure, as determined in different seasons, is given in the following table:

Fertilizing ingredients in alfalfa during different seasons.

Year.	Pounds per acre.		
	Nitrogen.	Phosphoric acid.	Potash.
1886	261.6	39.6	203.5
1887	253.6	45.7	286.9
1888	299.2	52.4	292.2
1889	360.0	63.0	255.5

The value of scarlet clover (*Trifolium incarnatum*) for green manuring has been studied at the Delaware Station (*Del. B. 11, B. 16, R. 1890, p. 37*). The advantages which it appears to possess are that it is a winter-growing plant, and may therefore conveniently follow summer crops, such as cowpeas. It covers the soil at a season when it most needs it and decays very readily in the soil. Besides it yields well and is rich in fertilizing ingredients. On the station grounds it yielded as high as 13 tons 566 pounds per acre (exclusive of roots and stubble), containing 131 pounds of potash, 35 pounds of phosphoric acid, 115 pounds of nitrogen, which on a fair estimate are worth about $24. As a source of nitrogen in fertilizers for fruits, field crops, and vegetables, it has given highly satisfactory results, in some cases surpassing nitrate of soda.

Japan clover has been very successfully grown at the North Carolina Station (*B. 70*) and is strongly recommended as a renovator of worn soils.

(*Ala. Canebrake B. 3, B. 4, B. 7, B. 10, B. 11, B. 13, B. 14; Ala. College B. 14, n. ser.; B. 16, n. ser.; Conn. Storrs B. 3, B. 5, B. 6, R. 1888, p. 28, R. 1889, p. 67, R. 1890, p. 12, R. 1891, p. 19; Conn. State Bd. of Agr. R. 1878, p. 335; Del. R. 1890, p. 37, B. 16; Ga. B. 3, B. 13; Ind. B. 32; La. B. 20, B. 28; Md. R. 1891, p. 364; Mich. B. 68, Bd. of Agr. R. 1890, p. 130; Minn. R. 1888, p. 188; N. J. R. 1886, p. 171, R. 1889, p. 159; N. Y. State B. 16; N. C. R. 1879, p. 108, R. 1886, p. 77, B. 70, B. 72, B. 77; S. C. R. 1888, p. 127.*)

Grevillea.—The silk oak or "Australian fern tree," *Grevillea robusta*, is noted and illustrated as an ornamental plant in *Pa. B. 13*. A brief account is given of the genus, the species of which are generally shrubs, though this becomes a tree 60 feet high. In California *G. robusta* thrives as an ornamental shade tree, retaining the beauty of its graceful fern-like leaves through the winter as well as the summer months. The climate of Pennsylvania necessitates pot culture. This species and *G. annulata* are alluded to in *Cal. R. 1880, pp. 66, 67.*

Guava (*Psidium guayava*).—The guava has been planted at some of the subtropical stations. Two varieties, Catley's red and Catley's yellow, are reported (*La. B. 3, 2d ser.; Tex. B. 8*). A note on the pear-shaped guava in *Cal. R. 1880, p. 66,* indicates that it needs protection the first year in the region of the station at Berkeley. In *Cal. R. 1885–'86, p. 115,* there are notes upon the same, indicating that the Berkeley climate has proved too severe, but it seems to succeed further south in the State. Of the strawberry guava (Catley's) it is said, however, that "this delicious little fruit has proved hardy in the climate of Berkeley, and, although late, has produced ripe fruit for the last two seasons."

Guernsey cows.—See *Cows, tests of dairy breeds.*

Gum trees.—The black or sour gum and the tupelo gum (*Nyssa* spp.) are noted in *Ala. B. 2, n. ser.*). The sweet gum (*Liquidambar styraciflua*) is named in several lists. For Australian gum trees see *Eucalyptus.*

Gypsum.—SOURCE AND COMPOSITION.—Pure gypsum is a hydrated sulphate of calcium, containing 32.6 per cent of calcium oxide, 46.5 per cent of sulphuric acid, and 20.9 per cent of water. It is variously known as calcium sulphate, sulphate of lime, and land plaster. When deprived of its water by heat it constitutes the well-known plaster of Paris. As found in the market it contains various impurities, principally insoluble matter and carbonate of lime or limestone. Deposits of gypsum are widely distributed in the United States, being found in quite large amounts in New York, Ohio, Illinois, Virginia, Tennessee, Texas, Kentucky, California, Michigan, and Iowa. The best gypsum is brought from Nova Scotia. This contains 94 per cent of hydrated sulphate of calcium, 2 per cent of insoluble matter, and 4 per cent of carbonates. A large supply of a lower-grade gypsum comes from Cayuga and Onondaga counties, New York. This contains on an average 65-75 per cent of pure gypsum, 6–8 per cent of insoluble matter, and 18–28 per cent of carbonate of lime (*Conn. State R. 1882, p. 50*). For composition of commercial gypsum see *Appendix, Table IV.*

USES.—The action of gypsum as a fertilizer is not well understood. It appears to act indirectly in the soil, setting free plant food, especially potash, already present, but contributing little directly to the support of plants. Its beneficial action on clay soils is probably due to its power of flocculating such soils, thus improving the drainage and mechanical condition, and of setting free the potash which such soils contain, largely in insoluble form. It is extensively used as a top dressing for clover and other legumes. The beneficial effect on these crops may probably be explained by the fact that legumes are preëminently potash feeders and thrive best on a pervious soil. It also promotes nitrification.

Gypsum is used as an absorbent in manure heaps to prevent loss of ammonia. It has been claimed that this substance hastens germination and promotes the growth of young corn and potatoes (*N. J. B. 3*), but experiments have shown that there are conditions under which it is without effect not only on corn and potatoes, but also on grasses, millet, and even clover (*Kans. B. 30, B. 32; Ky. B. 22*). On the other hand gypsum has given good results on the light, dry, sandy jack-pine plains of Michigan (*Mich. B. 68*), on a variety of crops. The value of this substance as an antidote for alkali is discussed under alkali soils.

(*Cal. R. 1890, App. p. 38; Conn. State R. 1878, p. 33, R. 1882, p. 50; Fla. B. 6; Kans. B. 20, B. 30, B. 32; Ky. B. 22; La. B. 12; Mass. State R. 1891, p. 307; Mich. B. 68; N. J. B. 3, R. 1880, p. 39, R. 1881, p. 29, B. 13; N. Y. State R. 1888, p. 340; Ore. B. 13; Tenn. B. vol. II, 1; Vt. R. 1890, p. 31; Wis. B. 14.*)

Gypsy moth (*Ocneria dispar*).—This is a native of Europe, which has been introduced into this country within the past twenty-five years, and has already proved very destructive in portions of Massachusetts. The great range of plants on which it feeds makes it especially difficult to treat. Hardly a fruit tree, shade tree, or ornamental shrub escapes its attacks, while many garden and field crops are known to suffer from its ravages.

The female flies but little. She is of a yellowish-white color, with two or more wavy rows of brown on the wings. Each fore wing has near the center a kidney-shaped spot, above which is a small round spot of the same color. The male is smaller and darker-colored, but similarly marked. The moths measure from 1½ to 2¼ inches across their expanded wings. The eggs are laid in oval clusters, mingled with the hair from the under side of the abdomen of the female. Each cluster contains 400 to 500 eggs, and is deposited on the bark of trees, under boards, on fences and walls, or in any place affording the small protection needed. They are laid between July and September, and hatch from April to June. When first hatched the larva is brownish yellow, with a small black head. When full grown the caterpillars are about 2 inches long, dark brown or black, very hairy, with a yellow line down the back and along the sides. On each segment of the body are several tubercles, the first six sets of which are blue, the other red. They usually remain together, and when not feeding collect side by side on the trunk or branches of trees. They are so numerous and voracious as to soon strip a tree of its foliage.

Destroying the straw-colored clusters of eggs and the moths, together with the use of sprays of arsenites while the caterpillars are feeding, will tend to repress them (*Mass. Hatch B. 7, Special B. 1889, R. 1891, p. 5*).

Hackberry (*Celtis occidentalis*).—The merits of this tree for shade and ornamental planting are affirmed by the Iowa, Minnesota, and South Dakota Stations. It is native in those States as well as eastward, but has hitherto been little planted. In *Iowa B. 16* it is pronounced as attractive as any variety of the similar tree which is native and often planted in Europe. In *Minn. B. 24* it is considered to rival the white elm, though less hardy in dry ground. In *S. Dak. B. 23* it is recommended for its beauty, also as one of the best native fuel woods; while delighting in damp soil, it has, as there stated, grown successfully on upland.

Harlequin bug.—See *Cabbage bug, harlequin.*

Harrow.—See *Dynamometer tests of farm implements.*

Hawkweed.—See *Weeds.*

Hay.—For composition of mixed hay and of hay from various grasses, see *Appendix, Tables I and II.* For feeding trials with hay see *Cattle, feeding for beef and for growth, Silage* and *Sheep.* See also *Clover* and *Grasses.*

Heifers, feeding experiments with.—See *Cattle.*

Hellebore.—See *Insecticides.*

Hemlock (*Tsuga canadensis*).—The hemlock or hemlock spruce has been found at the Minnesota Station (*B. 24*) very hardy when planted among other trees, though generally reputed tender in the State. It is regarded as "well worthy of more extended use in somewhat sheltered locations." A plantation at the South Dakota Station (*R. 1888, p. 19, B. 12*) met with little success.

Hens.—See *Poultry.*

Hemp (*Cannabis indica*).—A test of 2 varieties of hemp from Japan was made at the Massachusetts Hatch Station (*B. 18*), and the practicability of growing hemp in that locality seemed to be shown, but its profitableness was gravely doubted. An analysis of hemp waste considered as a fertilizer is given in *Mass. R. 1889, p. 274*, see *Appendix, Table IV;* and in *Cal. B. 94* the amounts of the different ingredients withdrawn per acre by a crop are shown for the plant and its parts.

In *Ky. B. 18* and *B. 27* are recorded experiments to ascertain whether hemp can be grown successfully on old ground by means of commercial fertilizers and what fertilizing ingredients are demanded.

The latter experiment gave the conclusions "that hemp can be successfully grown on our worn blue-grass soils with the aid of commercial fertilizers; that both potash and nitrogen are required to produce best results; that the effect was the same whether muriate or sulphate was used to furnish potash; that the effect was about

the same whether nitrate of soda or sulphate of ammonia was used to furnish nitrogen; that a commercial fertilizer containing about 6 per cent of available phosphoric acid, 12 per cent of actual potash, and 4 per cent of nitrogen (mostly in the form of nitrate of soda or sulphate of ammonia) would be a good fertilizer for trial." *Ky. B. 24* is devoted to an investigation of the broom rape of hemp and tobacco (*Orobanche* [*Phelipæa*] *ramosa*), a parasite which had become seriously injurious within a few years. Rotation of crops, burning over infested fields, care in collecting seed for planting, and the use of fertilizers to stimulate the growth of crops are suggested as means of resisting the broom rape.

Herbs.—Tests have been made at the New York State Station (*R. 1884, p. 286, R. 1885, p. 193, R. 1886, p. 252*) of a large number of species and varieties of plants "known to seedsmen as herbs," or more fully as pot and sweet herbs. Many of these belong to the mint family, viz, balm, basil, catnip, horehound, hyssop, marjoram, peppermint, sage, summer savory, and thyme; and to the *Umbelliferæ*, viz, anise, caraway, chervil, cumin, dill, and fennel. Others variously related are benne-borage, burnet, dyer's madder, false saffron, fenugreek, gobo, horseradish, nigella, aromatique, rue, and sorrel. In the case of some, as basil and sage, several varieties were planted. A special note is made on the Florence fennel or finocchio, in which the base of the leaf stalk is broad and thick, and is cooked as a vegetable or eaten raw as a salad.

Many of these plants are grown at the California Central Station at Berkeley, (*R. 1888–'89 p. 201*).

Seeds of this class of plants have been the subject of germination tests, as reported in *N. Y. State R. 1883, pp. 67, 263; Ore. B. 2; Vt. R. 1889, p. 111.*

Herd's grass.—See *Grasses.*

Hessian fly (*Cecidomyia destructor*).—This is a small two-winged fly, about one-eighth of an inch long, of a dusky color, which appears in May and June and again in September and October. The female lays her eggs upon the top of the leaves, and upon hatching the grub follows down to the stalk, in which it becomes embedded, The larva is at first white and quite small. While lying between the sheath and the stalk it changes into the "flaxseed" stage, in which it resembles in shape and color a small flaxseed. In this way it passes the winter, to emerge in spring as a new fly. Its burrowing in the stalk so weakens the stem that it breaks down.

There are quite a number of natural enemies and they keep this pest nearly under control. Late seeding, burning stubble after harvest, sowing a small portion of the field early and plowing under after the wheat has become 2 or 3 inches high and the flies have laid their eggs, and using resistant varieties of wheat are all means by which its attacks may in whole or part be prevented. (*Cal. R. 1890, p. 312; Ill. B. 12; Ind. B. 1; Ky. B. 40; N. C. B. 78; Ohio B. vol. III, 11, B. vol. IV, 7; Tenn. Special B. E.*)

Hickory trees (*Hicoria* [*Carya*] spp.).—While the trees of this genus are of recognized value for their hard, heavy, and tough wood, they have not been the subject of much investigation at the stations. Plantations of hickory at the South Dakota Station, as yet little advanced, are noted in *B. 15* and *B. 20.* In California, where timber of the hickory quality is much needed, several species have been tried, but have proved to be of very slow growth, at least in their first stages (*Cal. R. 1880, p. 68, R. 1890, p. 237*). In Minnesota (*B. 24*) the bitternut hickory (*Hicoria minima* [*C. amara*]) is estimated as probably the hardiest and best form of hickory for general planting in that State, It is valuable for hoop poles and makes a pretty lawn or park tree. It grows very fast until it commences to fruit, but does not reach the size of other species. The same is specially recommended for hoop poles in *Mich. B. 32.*

In *Ga. B. 2* is recorded an investigation of the fuel value of "black" hickory (*H. alba* [*C. tomentosa*]), in which full ash analyses of the wood and the bark are given. For partial analysis see *Appendix, Table V.*

For the pecan, which belongs to this genus, see *Pecan.*

Hog cholera.—A disease of hogs due to the presence of minute organisms or bacteria in the alimentary tract. These increase with enormous rapidity when the conditions are favorable, and their minuteness and power of surviving against seemingly adverse conditions make the spread of the disease possible. The symptoms of the disease vary so much that a correct diagnosis is often impossible. The more common ones are loss of appetite; elevated temperature; cough; a watery discharge from the eyes, becoming thicker, often gumming the eyelids together; a change in the appearance of the skin on the under side of the neck, breast, and abdomen, which becomes drawn and of a reddish hue; and constipation, followed by a marked diarrhea, which may continue until the death of the animal. As the disease progresses the animals have a gaunt appearance, arched back, rough coat, and a weak, staggering gait. In acute cases or in chronic cases of considerable duration these symptoms may be so modified as to become undistinguishable. In acute attacks animals sometimes die within an hour after a hearty meal. In chronic cases the disease may drag its course for a month or more. In any case a post-mortem examination of the digestive organs, especially of the larger intestines, will give evidence of the presence or absence of the disease. If hog cholera be present the intestines will show more or less prominent ulcers and thickenings. The stomach, spleen, and liver may also give evidence of the disease. The rate of mortality among the affected animals is very high, only about 10 or 15 per cent recovering from an attack.

There is no known remedy for hog cholera, but whatever contributes toward keeping the swine in a good, healthy condition will perhaps render them less liable to its attack.

When the disease appears all healthy animals should be at once removed to some distance from the sick and suspected. Do not let well animals have access to the same water as the sick, as is sometimes done along streams or ponds. Burn or bury deep the carcasses of all dead animals, not leaving them where buzzards have access to them. Clean and disinfect all pens used by diseased animals, and do not use them for some months for well animals, as the germs of the disease are held in the soil and retain their vitality for a considerable time. Quarantine all animals from suspected localities for several days before introducing into the herd. In this way the epidemic may often be avoided.

It has been claimed that inoculation will secure immunity from attacks of cholera, but upon what seems good evidence others deny such immunity, and affirm that inoculation may introduce an epidemic of the disease where it otherwise might not have occurred. (*La. B. 10, n. ser.; Me. R. 1889, p. 257; Nebr. B. 4; Ohio R. 1890, p. 38; S. C. R. 1889, p. 181, B. 6.*)

Hogs.—See *Pigs.*

Holderness cows.—See *Cows, tests of dairy breeds.*

Holly (*Ilex* spp.).—There are several species of holly in the South, as noted in *Ala. College B. 2, n. ser.*, of which the only one of much size is *I. opaca.* As there represented, the wood of this tree is of an ivory whiteness except near the center, hard, and compact, fine-grained and susceptible of polish, and valuable for engraving and for cabinetwork, taking a durable stain of almost any shade. The tree is easily grown and makes excellent hedges.

Hollyhock blight (*Colletotichum malvarum*).—This is especially serious in the greenhouse, it having been impossible in several instances to grow seedlings on account of its ravages. It may attack any part of the plant. The color of spots may vary from light yellow to brown or black. It causes a shriveling of the part attacked and sooner or later spreads over the whole plant, ending in its destruction. Bordeaux mixture has so far proved the best fungicide for this disease. (*N. J. R. 1890, p. 361, R. 1891, p. 297.*)

Hollyhock leaf spot (*Cercospora althæina*).—This fungus flourishes on the hollyhock as well as on some of its near relatives, notably upon the "velvet leaf" or

Indian mallow. The lower leaves begin to show brown spots, circular in outline; these increase in size until they occupy all the space between the veins; the leaf wilts and drops before any flowers appear, often leaving the whole stalk bare. This disease has been known to invade the greenhouse in winter and attack the young seedlings in the propagating boxes to such an extent that raising of healthy plants seemed impossible. Frequent and thorough spraying with ammoniacal carbonate of copper has proved an effective remedy for this disease. (*N. J. R. 1890, p. 361, R. 1891, p. 297.*)

Hollyhock rust (*Puccinia malvacearum*).—This disease is a native of South America, and has come to us by way of Europe, where it has been known since 1869. It was introduced into this country about 1885, and its ravages are causing considerable anxiety among florists growing hollyhocks on any considerable scale. Wherever it has become established it appears in May or June on the leaves, leaf stalks, and stems, having apparently wintered upon the root leaves. At first the spots are yellow, but on the under side of the leaf they become wartlike, and brown or gray in color. These spots may increase in size and number until a considerable portion of the leaf is involved, resulting in the fall of the leaf, or if they do not cause the leaf to die it is greatly stunted in its growth. Where the leaf is killed it has a dried and parched appearance long before time for the flowers, if indeed any ever appear. Several remedies have been tried in Europe, and one of the best is as follows: Saturated solution permanganate of potash 2 tablespoonfuls, water 1 quart. Apply directly to the spots and diseased leaves with a sponge and not a sprayer or sprinkler. This is a cheap remedy, and is said to be very effective. All badly diseased plants should be destroyed by fire.

(*Mass. State R. 1890, p. 224; N. J. R. 1890, p. 261, R. 1891, p. 297; N. Y. Cornell B. 25; Vt. R. 1890, p. 144.*)

Holstein cows.—See *Cows, tests of dairy breeds.*

Horn fly (*Hæmatobia serrata*).—This is a recent introduction from Europe, which proved very troublesome to cattle a few years ago. It has been carefully studied and many new facts learned by the entomologist of the New Jersey Station concerning its habits and life history.

It is smaller than the common house fly, but greatly resembles it. They usually appear in droves and being very blood-thirsty annoy the cattle greatly. Their habit of collecting in great numbers about the base of the horns has given them their name. They attack cattle in places where they are not easily warded off and quickly cut through the skin to suck the blood, and will only stop when killed or driven away. During the sucking process the insect injects a fluid into the wound that is very irritating, causing the blood to flow more freely and making the animal very uneasy.

Dusting insect powder or finely powdered tobacco over cattle will kill the flies, but it must be repeated twice a day. Train or fish oil rubbed on the parts most frequented, as the back and legs and around the horns, will keep them away.

The eggs are deposited in the fresh droppings and covering them with lime or spreading so as to cause them to dry quickly will prevent hatching. (*Iowa B. 13; Ky. B. 40; Miss. R. 1891, p. 33; N. J. B. F, B. 62, R. 1889, p. 245; N. Y. Cornell B. 37; W. Va. R. 1890, p. 159.*)

Horse nettle.—See *Weeds.*

Horse-radish (*Cochlearia armoracia*).—A plantation of this condimental root in the class of "herbs" is noted in *N. Y. State R. 1885, p. 193.* An analysis is given in *Mass. State B. 16*, for which see *Appendix, Table III.*

Horse-radish, leaf spot (*Septoria armoraceæ*).—This disease is probably the worst attacking horse-radish. The leaves turn yellow and become full of holes until the leaf is completely riddled. It soon becomes lifeless, brittle, and dies whenever the fungus is present in any considerable quantity. (*N. J. R. 1890, p. 360.*)

Horse-radish, white mold (*Ramularia armoraceæ*).—This develops in considerable quantity upon the leaves, giving them a whitish appearance. It causes considerable injury, but is not as destructive as the leaf spot disease. No remedy is suggested. (*N. J. R. 1890, p. 360.*)

Horses and colts.—Experiments with these animals have been very limited. A comparison at Maine Station (*R. 1890, p. 68*) of oats with a mixture of one-third pea meal and two-thirds middlings for Percheron colts showed no advantage of the oats over the grain mixture.

The Utah Station has reported trials of watering horses before and after feeding grain, and of feeding whole *vs.* ground grain (*B. 9*), grain and hay mixed, and cut hay (*B. 13*).

"Horses wearing blankets beneath their harness in the day and blanketed in the stables at night did not hold their weight as well as those without blankets" (*Utah B. 11*).

Hovenia.—Trial has been made at the California Central and Southern Stations (*R. 1880, p. 69, R. 1885–'86, p. 116*), of the *Hovenia dulcis*, a Japanese deciduous tree of the buckthorn family. It had been recommended as a hedge plant and it bears a fruit considerably esteemed in Japan. It had not fruited in California, but both at Berkeley and in Southern California it had proved a handsome, rapidly growing tree. Specimens five years old had straight, smooth trunks 6 feet high and well-developed crowns. The leaf is shaped like that of a linden. "Even if the fruit should prove of little value the tree will stand well for shade and ornament."

Huckleberry.—(*Vaccinium* spp.).—Some effort has been instituted at the New York State Station to introduce the huckleberry into cultivation. Notes upon this subject occur in *N. Y. State R. 1882, p. 145, R. 1883, p. 227, R. 1885, p. 231.* The huckleberry, by which is meant chiefly the high bush or swamp huckleberry or blueberry (*V. corymbosum*), is considered to possess better natural qualities than either the currant or the gooseberry. The testimony is adduced of some who had successfully grown the huckleberry upon ordinary farm soil. From the variability of the wild plant it is inferred that the cultivated plant will be still more variable. Propagation by seed was found a slow and difficult process both at the Arnold arboretum and in experiments at this station. Some directions are given for the treatment of transplanted plants and for planting seed.

Hungarian grass [also called German millet].—See *Millet.*

Husk tomato.—See *Physalis.*

Ichneumon flies.—A class of insects which deposit their eggs in the bodies of the larvæ of other insects, especially those commonly known as caterpillars. As the eggs develop the caterpillar is killed. By the aid of these friendly flies many pests are held in check. (*Nebr. B. 14; N. C. B. 78.*)

Idaho Station, Moscow.—Organized February 26, 1892, as a department of the State University under the act of Congress of March 2, 1887. Substations have been established at Grangeville, Idaho Falls, and Nampa. The station staff consists of a director, irrigation engineer, chemist, botanist, entomologist, meteorologist, and three agriculturists. The principle lines of work are experiments with field crops, fruits, and vegetables, and irrigation. Up to January 1, 1893, the station had published two bulletins. Revenue in 1892, $15,000.

Illinois Station, Champaign.—Organized April 1, 1888, as a department of the University of Illinois, under the act of Congress of March 2, 1887. The staff consists of the regent of the university, president of the board of direction and agriculturist, horticulturist and botanist, chemist, consulting entomologist, consulting veterinarian, assistant horticulturist, assistant botanist, assistant chemist, assistant agriculturist, and secretary. The principal lines of work are chemistry, field experiments with crops, horticulture, diseases of plants, feeding experiments, and dairying. Up to January 1, 1893, the station had published 4 annual reports and 23 bulletins. Revenue in 1892, $15,000.

Imported cabbage butterfly.—See *Cabbage butterflies.*

Imported currant worm.—See *Currant worm, imported.*

Indiana Station, Lafayette, organized July 1, 1887, as a department of Purdue University, under act of Congress of March 2, 1887. The staff consists of the president of the university, director, agriculturist, horticulturist, chemist, botanist, veterinarian, assistant botanist, assistant chemist, secretary, and treasurer. The principal lines of work are field experiments with fertilizers and crops, horticulture, feeding experiments, and diseases of plants and animals. The station has published 5 annual reports and 32 bulletins. Revenue in 1892, $16,553.

Indian mallow.—See *Weeds.*

Insecticides.—For apparatus for application see *Fungicides.* Brief statements regarding the leading insecticides are given below.

ARSENIC.—White arsenic or arsenious acid. This is sometimes used as an insecticide but is unsafe, its color allowing it to be mistaken for other substances. Its compounds are both safer and surer.

ARSENITES.—There are two leading compounds of arsenic, Paris green and London purple, either of which is a valuable insecticide.

London purple is a fine powder and is cheaper than Paris green. It is a by-product and is not constant in its analyis. It may be effectively used diluted either as a powder or solution. It should never be used on peach trees as it is liable to injure the foliage. If used dry a convenient formula is, London purple, 1 pound; flour, 10 pounds; road dust, lime, or coal ashes, 20 pounds.

If used as a liquid a good formula is, London purple 1 pound; water, 200 gallons. A little glue or flour paste may be added to cause it to adhere better.

Paris green is more constant than London purple in the proportions of arsenic it contains. If used dry the formula for London purple may be followed, but if in solution the following formula will be found better: Paris green, 1 pound; water, 100 gallons. If it is to be used on peach trees dilute one-half.

These two compounds are very effective when used against any insect that eats the foliage or fruit of any plant. They will have little or no effect on those living by sucking the sap or juices from the plant or fruit.

BISULPHIDE OF CARBON.—This is a very thin volatile fluid, the fumes of which are destructive to all animal life. It is highly inflammable and should never be used near fire. It may be used to kill insects in the ground by making a hole into which a little is poured, the hole being closed immediately. It may also be used on stored grain, peas, beans, etc., placed in tight receptacles with a little of the liquid.

BORDEAUX MIXTURE.—See *Fungicides.* This is also recommended as an insecticide. A combination of Paris green or London purple (2 ounces) and Bordeaux mixture (22 gallons) is often used against fungi and insects at one spraying.

BUHACH.—See *Pyrethrum.*

CARBOLIC ACID.—This may be used for root insects in proportion of one to fifty or 100 parts of water, or as emulsion for a wash. The emulsion may be made as follows: Carbolic acid (crude), 1 pint; soft soap, 1 quart; hot water, 2 gallons. Mix thoroughly and apply with a cloth or stiff brush for plant lice and stem borers. It must not be applied to foliage.

FERTILIZERS AS INSECTICIDES.—See *Fertilizers.*

HEAT.—This is recommended for the pea and bean weevils. A temperature of 135° to 145° F. will kill the insects and not injure the seed.

HELLEBORE, WHITE.—This is used dry and dusted over currant and gooseberry bushes for the currant worm. It may be used in solution (1 oz. to 3 gallons of water) and sprayed over bushes. It is very effective when fresh but loses its strength by standing.

HOT WATER.—Plants may be sprayed with hot water or dipped in it for an instant to kill plant lice. The temperature of the water should be about 125° F.

KEROSENE.—This is not only a good repellent, but acts also as a destroyer of insects. If used alone it will injure some plants and on these it is best to use a kerosene emulsion, for which two leading formulas are given, as follows: Soft soap 1 quart, water 2 quarts, kerosene 1 pint; or, hard soap ½ pound, water 1 gallon, kerosene 2 gallons.

Dissolve the soap in the boiling water, remove from the fire and add the kerosene. Stir or churn violently until the emulsion becomes the consistency of thick cream, and no oil rises to the top. This can be best done by pumping through a force pump, returning through the nozzle into the same vessel. For use dilute with water (2 gallons for the first formula). To the second formula from ten to fifteen parts of water should be added, depending upon the plants to be sprayed, some enduring a stronger solution than others. The emulsion may be used against all sap-sucking and soft-bodied insects and is one of our most valuable insecticides.

An ointment is made of kerosene, ½ pint; sulphur, 2 ounces; and lard, 1 pound. Mix lard and sulphur and add oil. Apply by rubbing. This is valuable to destroy vermin on fowls and animals.

LIME.—This is either dusted over plants in a dry state or applied as a whitewash to trunks of trees, etc.

PYRETHRUM.—This is sold as a fine light-brown powder, made by pulverizing the flower heads of several species of *Pyrethrum*. There are three kinds in the market, known as buhach, a California product, and Dalmatian and Persian insect powder. They are equally effective when fresh, but lose strength when exposed to the air. They may be dusted over plants or applied with a bellows. A good way to apply is by spraying with the following mixture: Pyrethrum, 1 tablespoonful; boiling water, 2 gallons.

Stir well and apply at once. If the powder is to be dusted or sifted over plants dilute with two to ten times its quantity of flour or ashes. Instead of pure kerosene in the emulsion mentioned above, a decoction may be used of 1 gallon of kerosene filtered through 2½ pounds of fresh pyrethrum. This is a most valuable form in which to use these combined insecticides. Pyrethrum kills by contact and on this account must be applied frequently so long as the insects are troublesome. For vegetables like cabbage, lettuce, and celery, when one does not care to use Paris green, this will be found equally good and perfectly safe.

RESIN COMPOUNDS.—These are known to be very effective against scale insects, especially those of the citrus fruits. One of the best formulas is, caustic soda, 1 pound; resin, 8 pounds.

Dissolve soda in 1 gallon of boiling water. Remove half and add resin, boiling until dissolved. Slowly add remainder and dilute until it can be strained through a thin cloth. Dilute to 32 gallons before using. Two ounces of Paris green or London purple may be added to this when used.

SOAPSUDS.—Strong soapsuds made from any ordinary lye soap or from whale-oil soap or strong potash soaps are recommended as washes for plants infested by plant lice.

TAR.—This is an excellent thing to drive away insects or to entrap them. Applied to the exposed parts of animals it will keep away not only the dangerous insects, but those which harass the brutes.

TOBACCO.—This is a valuable insecticide and may be applied in several ways, either as fine dry powder, with whale-oil soap, the fumes from its burning, or a decoction of 2 gallons of water to 1 pound of tobacco. The stems, refuse, and dust are used for this purpose. It is effective against flea beetles, plant lice, and ticks.

MISCELLANEOUS.—The following substances have been tested as insecticides and reported upon: Acetic acid, alum, corrosive sublimate, digitalis, kainit, naphthaline, nicotinia, quassia, and sludge-oil soap (*N. J. B. 75*); benzoic acid, lead acetate, corrosive sublimate, oxalic acid, potassium bichromate, salicylic acid, santonin, sludge, tartar emetic, and veratrin (*Ark. B. 15*); carbolized plaster and potassium cyanide (*Mich. B. 58*); fir tree oil (*N. Y. Cornell B. 28*); gas lime and salt (*N. Y. Cornell B. 33*); camphor (*Ore. B. 5*); and copperas (*Iowa B. 12*).

(N. J. B. K., B. 75; Ark. B. 14; Fla. B. 9, B. 14; Iowa B. 10; Ohio B. vol. III, 4, B. 8; Ky. Circular 3; Mich. B. 58, B. 83; N. Y. State, B. 1890, p. 307; N. C. B. 78; Del. B. 12, R. 1890, p. 119; Iowa B. 12, B. 14; Mass. Hatch B. 13.)

Insect-powder plants.—See *Pyrethrum.*

Iowa Station, Ames.—Organized February 17, 1888, as a department of the Iowa State College of Agriculture and Mechanic Arts, under the act of Congress of March 2, 1887. The staff consists of the president of the college, director, assistant director, chemist, botanist, entomologist, horticulturist, veterinarian, assistant agriculturist, assistant veterinarian, assistant botanist, assistant entomologist, assistant horticulturist, secretary, and treasurer. The principal lines of work are chemistry, field experiments with crops, horticulture, diseases of plants, entomology, and dairying. Up to January 1, 1893, the station had published 3 annual reports and 19 bulletins. Revenue in 1892, $15,350.

Iowa Station milk test.—See *Milk tests.*

Ironwood (*Ostrya virginica*) [also called Hop hornbeam].—"A pretty native tree, of medium size, that does well under cultivation," is generally hardy, but prefers some protection, and does best in moist, rich land (*Minn. B. 24*).

Irrigation—Use and value.—In the Eastern States irrigation is practiced only to a limited extent (principally on meadows), but west of the Mississippi River, in the Utah valleys, and even in California, the scanty rainfall renders irrigation necessary and its immense value over these areas is being more fully appreciated each year. In the Southern States rice of course is grown by irrigation, and experiments with other crops, notably sugar cane, have given such favorable results that irrigated areas are being increased. The extent to which irrigation is practiced in the western half of the United States is indicated by the estimates given in the following table taken from a report on Irrigation and the Cultivation of the Soil Thereby, published by the U. S. Department of Agriculture:

Irrigation areas and artesian wells west of the ninety-seventh meridian.

State and Territory.	Average. Under ditch. 1889.	1890.	1891.	Cultivation. 1890.	1891.	Number of artesian wells.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	
Arizona	529, 200	643, 450	660, 000	310, 100	316, 000	45
California	3, 294, 000	4, 044, 000	4, 500, 000	3, 444, 000	3, 550, 000	3, 500
Colorado	2, 813, 273	4, 082, 738	4, 200, 900	1, 585, 000	1, 757, 162	4, 500
Idaho	715, 500	1, 181, 500	1, 200, 000	327, 000	330, 000	12
Kansas west of 97° of longitude	500, 000	860, 101	900, 000	100, 000	120, 000	250
Montana	986, 000	1, 100, 000	1, 250, 000	400, 000	410, 000	36
Nebraska west of 97° of longitude	50, 000	65, 000	200, 000	10, 000	40, 000	100
Nevada	142, 000	150, 000	150, 000	75, 000	100, 000	76
New Mexico	638, 455	677, 315	700, 000	450, 000	465, 000	10
North Dakota	....	1, 000	2, 500	1, 500	2, 000	670
Oregon, east of Cascades	75, 000	100, 000	125, 000	45, 000	45, 000	6
South Dakota	100, 000	100, 000	100, 000	22, 000	54, 000	950
Texas west of 97° of longitude	200, 000	340, 000	350, 000	160, 000	160, 000	1, 000
Utah	700, 000	700, 000	735, 226	413, 000	423, 364	2, 524
Washington, east of Cascades	75, 000	150, 000	175, 000	60, 000	75, 000	10
Wyoming	1, 916, 876	2, 172, 781	3, 038, 481	175, 000	180, 000	6
Total	12, 765, 304	16, 367, 794	18, 286, 207	7, 577, 600	8, 026, 526	13, 695

The increase from irrigation is sometimes fourfold and seldom less than double (Allen). It is estimated that "if only 1 acre in 4 could be reclaimed it would still bring the product of the arid region [of the United States] up to the product of the balance of the country."

In experiments at the Louisiana Station (*B. 14*) irrigated soils yielded 34 tons of sugar cane per acre and unirrigated soils about 8 tons. The value of the cane for sugar-making was about the same in each case. Corn on irrigated soil yielded 100 bushels per acre and sorghum, cotton, and cowpeas responded readily to irrigation.

The chief advantage of irrigation is thus concisely stated by Dr. Stubbs of the Louisiana Station. "Irrigation eliminates the great element of chance from our farming operations and [with] good drainage makes the planter nearly independent of the freaks and idiosyncrasies of the weather."

Irrigation in connection with underdraining has long been urged as "the general and absolute correction for alkali" (*Cal. R. 1890, App. p. 34*) and this method has been of very great value in reclaiming these otherwise fertile soils. (See *Alkali soils.*)

The marked effect of irrigation in increasing rainfall has been noticed (*Nebr. B. 1*) but no exact observations on this point have been reported by the experiment stations.

See also *Colo. R. 1890, p. 72; Ariz. B. 3.*

SYSTEMS OF IRRIGATION.—Systems of irrigation may be divided into two classes, surface irrigation and subirrigation. The first class includes the old methods of flooding and row or furrow irrigation in which the water is spread over the surface of the land by suitably arranged shallow trenches and confined on it by means of raised borders. Subirrigation is accomplished either by digging the ditches which spread the water, deep and close together, so that the water spreads by lateral absorption, or by an underground system of perforated pipes. Full discussions of different methods of irrigation will be found in *Ariz. B. 3; Nebr. B. 1; S. Dak. B. 28; Wyo. B. 8.* The laying of underground irrigation pipes is described in *La. B. 14; Nebr. B. 6.*

Subirrigation is the most expensive system, but is generally considered the most effective. In experiments at Louisiana Station (*B. 14*) little difference between the two methods was observed. Subirrigation by means of pipes is peculiarly applicable to alkali soils (*Cal. R. 1890, App. p. 32*), since it economizes water and is especially effective in removing the alkali. On account of its expense it can only be adopted as a last resort on very fertile soils.

The results of experiments in irrigation at the Wyoming Station are thus summed up in *B. 8, p. 31:* "Over-irrigation is pernicious and must be avoided. Of the methods of irrigation, flooding is the most injurious to cultivated crops, but the most economical method for grass lands cereals. Row irrigation is recommended for all crops where it is convenient to apply it. Subirrigation is the most expensive but most favorable to the majority of crops. It works best on rather heavy soils with impervious subsoils."

WATER SUPPLY AND STORAGE.—In humid regions there is little trouble in securing all the water needed for purposes of irrigation. In the arid regions of the West, however, expensive reservoirs and canals are built, and in many cases artesian wells are sunk in order to secure the necessary supply of water. The proposition has been advanced, however, that on the Great Plains at least, "the security of the agriculturist is to be chiefly accomplished [not by any great system of storage, but] by small-farm storage, by the impounding of the little streams, by the utilization of springs, and by the restoration to the surface through artesian drills or by the mechanical lifting from other bored wells of the waters that are stored below the surface soil in the earth itself" (Hinton). The locating of extensive artesian basins throughout the arid and semi-arid regions of the West has given a great impetus to irrigation in those regions.

The value of the water from different sources for irrigation purposes has been studied by the Colorado (*B. 9*) and California Stations (*R. 1890, App. p. 41*). These

investigations have emphasized the necessity of a careful examination of the water supply for irrigation and of thorough drainage of the soil irrigated to prevent the soils from becoming surcharged with deleterious salts (alkali). Results of experiments with artesian water in these and other States are generally favorable to this water supply.

The question of evaporation from reservoirs has been studied at the Colorado Station (*R. 1889, p. 51, R. 1891, p. 50*). From observations on floating and stationary tanks the following formula for evaporation for one day has been obtained: $E = 0.39 (T - t) (1 + 0.02 W)$, in which T is the vapor tension of the temperature of the surface of the water; t the vapor tension of the air; W the movement of the wind. The total observed evaporation from a tank during one hundred and fifty-six days in 1890, was 23.30 inches; computed by the above formula, 23.74 inches.

Measurement, division, and duty of water—One of the most important as well as one of the most difficult problems of irrigation is that of making a just distribution of water. The various devices used for this purpose have been studied by the Colorado (*B. 13*) and Wyoming Stations (*B. 8*). Extensive investigations at the Colorado Station have led to the recommendation of the overfall or sharp-crested weir. The Cippoletti trapezoidal weir appears to be especially commendable. Various instruments for giving a continuous record of the time and depth of water flowing over weirs are described and illustrated (*Wyo. B. 8*)

The duty of water taken as the basis of water rights in Colorado is 55 acres per second-foot. Observations on the Cache a la Poudre Canal No. 2 during 1890 indicated that the duty of water from April to September was 196 acres per second-foot (*R. 1890, p. 65*). Similar observations in Wyoming show that the duty of water varied from 93.5 to 735.3 acres per second-foot. In California and Utah 100 acres per second-foot is adopted as the standard.

The amount of irrigation best suited to different crops is discussed in *Colo. R. 1891, p. 54; S. Dak. B. 28; Wyo. B. 8.*

Seepage.—"After a country has been irrigated for some time there are some changes in the régime of streams, so that these are more regular in their flow, especially in the dry season; often they may be repeatedly drained to the last drop and soon after have enough to make a respectable stream. Most of this return is from invisible sources, or in quantities too small to measure. While an increase in the volume of streams is noticed in a non-irrigated country, in many of the irrigated valleys the return is attributed to irrigation. * * *

"We have not observations which will absolutely prove that this increase is due solely to irrigation, but the fact familiar to all irrigating countries, that land previously dry becomes saturated and requires draining because of the seepage from ditches or irrigated lands of higher location, and other analogous facts, render it very probable that most if not all of the return observed is due to the return from the waters which have been applied in irrigation. * * * It is possible that irrigation in the upper valley of a river is beneficial to the lower valley by the return water in the season during the period of low water."

Measurements of this seepage during a number of years indicate that in the Poudre Valley, Colorado, it is one-third of the flow of the stream. Contrary to the prevailing idea seepage does not appear to be increasing (*Colo. R. 1891, p. 45*).

(*Ariz. B. 3, B. 4; Cal. R. 1890, App.; Colo. B. 1, B. 9, R. 1888, p. 164, R. 1889, pp. 56, 68, B. 16, R. 1890, pp. 58, 100, B. 13, R. 1891, p. 45; La. B. 14; Nebr. B. 1, B. 6; N. Mex. B. 4; S. Dak. B. 28; Wyo. B. 8.*)

Italian rye grass.—See *Grasses.*

Jamestown weed.—See *Weeds.*

Japan clover.—See *Lespedeza.*

Jersey cows.—See *Cows, tests of dairy breeds.*

Jersey-red swine.—See *pigs.*

Jerusalem artichoke.—See *Artichoke.*

Jerusalem corn (*Sorghum vulgare* var.).—A non-saccharine variety of sorghum, which grows 4 to 8 feet high, and is chiefly valuable for the large amount of grain which it produces. The seeds are nearly free from husk and shatter easily. At the Nebraska Station (*B. 19*) the yield of threshed seed was 49 bushels per acre. Jerusalem corn is an annual and is cultivated like other sorghums. In weight of forage it is surpassed by many kindred plants.

Johnson grass.—See *Grasses.*

June berry.—See *Service berry.*

Jute (*Corchorus capsularis* and *C. olitorius*).—An annual fiber plant, a native of India. It requires a warm climate and moist, strong soil. It has been successfully grown in the Gulf States, but the want of a suitable machine for separating the fiber is the great obstacle which prevents the growth of the jute-fiber industry in this country. (*Cal. B. 84, B. 89, 1890, p. 291.*)

Kaffir corn (*Sorghum vulgare* or *Andropogon sorghum* var.).—This is a kind of non-saccharine sorghum similar to durra (see *p. 121*). The common white variety has a short and stocky stalk, with short joints and very little juice. The leaves are large and numerous. The heads grow erect in large panicles and bear large white seeds which are excellent for feed, especially for poultry.

As grown at the Kansas Station (*B. 18*) in an ordinary season it ripens before frost and gives a good yield. It suffers relatively little injury from winds. If retarded by drought the seeds are poorly developed and liable to mold. The red variety is somewhat taller, with slender and more juicy stalks. The seeds are red, smaller, and very hard and brittle. It does well on poor land and ripens a little earlier than the white variety (*Kans. B. 18*).

In California Kaffir corn has been found to be a valuable crop, yielding several large cuttings of forage each season if the ground is sufficiently moist. It is one of the main sources of feed for poultry in that State (*Cal. R. 1890, p. 210*).

In Louisiana Kaffir corn may be planted in March or early in April and furnishes a large amount of excellent green fodder. On good land from 50 to 60 bushels of seed per acre are produced (*La. B. 8, n. ser.*).

At the Nebraska Station (*B. 12, B. 19*) Kaffir corn is recommended as producing early seed and fodder. In the favorable season of 1891 this crop, planted April 29 and harvested October 30, yielded 112½ bushels of seed per acre.

At the Georgia Station (*B. 12, B. 17*) the yield per acre at three cuttings was from 8 to 16 tons of green fodder and 2½ to 3½ tons of dry fodder. These yields, however, were smaller than those produced by other forage plants in the same seasons. This station also reports the composition of the crop at the different cuttings.

Kaffir corn is recommended by the North Carolina Station (*B. 73*) as the best of the non-saccharine sorghums grown for forage.

At the Alabama Canebrake Station (*B. 9*) on black bottom soil Kaffir corn made a short and stocky growth and was not eaten readily by cattle.

At the Pennsylvania Station (*R. 1888, p. 43*) the total crop was 5½ tons per acre, containing 119 pounds of digestible protein, 34 of fat, and 941 of carbohydrates.

In Michigan (*B. 47*) Kaffir corn was inferior to silage corn for forage.

At the New York Cornell Station (*B. 16*) an analysis of this crop cut September 18 when quite immature gave the following results: Water 76.05 per cent, dry matter 23.95, protein 2.34, fat 0.41, nitrogen-free extract 11.40, fiber 8.36, ash 1.44. This shows a relatively large amount of protein. The growth of green fodder was, however, relatively small. (See also *O. E. S. B. 11, p. 30*).

Kai apple (*Aberia caffra*).—A thorny shrub from South Africa, which has been planted at the several California Stations, and seems to do well, though sensitive to the lightest frosts. It is suitable for hedges (*Cal. R. 1888-'89, pp. 87, 110, 138, R. 1890, p. 237*).

Kainit.—See *Potash.*

Kaki.—See *Persimmon.*

Kale.—A member of the cabbage group of vegetables, also called borecole, "extensively grown in Europe for the table and as a food for cattle. It produces a crown of leaves, but does not form a head." A dwarf variety is often sown in the fall, wintered over like spinach, and used for greens under the name of "sprouts" or "German greens." This and other information is given in *Mich. B. 48*, where also 9 varieties are described, which were planted at the station with seed obtained from Paris. Kale has also been planted at the New York State Station (*R. 1882, p. 134, R. 1883, p. 188, R. 1884, p. 287*). The leaves in different varieties are curled, cut, and variegated.

Germination tests of kale seed are reported in *N. Y. State R. 1883, pp. 69, 263; Ohio R. 1884, p. 197; Vt. R. 1889, p. 105.*

Jersey kale is noted in *Cal. B. 81* as a tall-growing collard, and is recommended for trial to dairymen who have moist land available. This is doubtless the same as the plant described in *Minn. R. 1888, p. 267,* under the name of cow cabbage. As there stated, we have in this "a variety which under special cultivation in the Jersey Islands has developed an immense amount of leaf-producing surface. They are commonly grown on rich lands to the height of 10 or 12 feet and with branches. One instance is recorded of the height of 16 feet being reached."

Kansas Station, Manhattan.—Organized February 8, 1888, as a department of Kansas State Agricultural College, under act of Congress of March 2, 1887. The staff consists of the president of the college and chairman of station council, chemist, horticulturist and entomologist, agriculturist, physiologist and veterinarian, botanist, assistant chemist, assistant horticulturist, assistant entomologist, assistant agriculturist, assistant botanist, foreman of farm, and secretary. The principal lines of work are field experiments with crops, horticulture, diseases of plants and animals, feeding experiments, and entomology. Up to January 1, 1893, the station had published 4 annual reports and 36 bulletins. Revenue in 1892, $15,000.

Kellogg system of creaming milk.—See *Creaming of milk.*

Kentucky Station, Lexington.—Organized in September, 1885, by the trustees of the Agricultural and Mechanical College of Kentucky; reorganized under State authority April, 1886; and reorganized for the second time in 1888 under act of Congress of March 2, 1887. The staff consists of the president of the college, director, two chemists, entomologist and botanist, assistant entomologist and botanist, veterinarian, and horticulturist. The principal lines of work are chemistry, analysis and inspection of fertilizers, field experiments with fertilizers and crops, horticulture, diseases of plants, entomology, and dairying. Up to January 1, 1893, the station had published 2 annual reports and 43 bulletins. Revenue in 1892, $18,509.

Kerosene emulsion.—See *Insecticides.*

Kidney vetch (*Anthyllis vulneraria*).—This is a European leguminous plant, also called horned-pod clover. It has been planted on trial as a forage plant at a few Western stations, but no important result has been obtained. It is noted in *Colo. R. 1890, p. 161,* and contained in lists in *Cal. App. to R. 1885–'86, p. 98; Wyo. B. 1*).

Knot-grass.—See *Weeds.*

Kohl-rabi.—"This plant is a bulb-stalked cabbage, a native of Germany, where it is much cultivated both for forage and as an article of human diet. The stem of the kohl-rabi above ground is swollen into the form and proportions of a handsome symmetrical tuber" (*Kans. R. 1889, p. 47*). This and further descriptive matter accompanies an account of experimental plantations, resulting in strong recommendations of this crop for that State. The first year the kohl-rabi maintained itself through a drought which quite burned up the corn and when rains came developed a large crop. The tops were eagerly eaten by cattle at harvesting; the bulbs were preserved under straw and earth till spring, when they were relished by cows and calves. The second year the crop was 22.79 tons per acre. Directions are given for growing and the expense involved calculated (3.69 cents per bushel). Analyses of

the 2 varieties raised (*Kans. R. 1889, pp. 113, 116*) presented the interesting result that a large part of the nitrogen present is non-albuminoid. In the dry substance of the purple variety the total nitrogen was 4.06 per cent, the albuminoid 1.02; in the green variety total 3.12 per cent, albuminoid 0.85. For general analyses see *Appendix, Table III.*

In *Minn. R. 1888, p. 257*, 4 varieties grown at that station are described and the vegetable represented as not duly appreciated for the table. The growth of a plantation at the New York State Station is noted (*R. 1882, p. 134*). At the same station the root system was studied (*R. 1884, p. 313*). The taproot was traced to a depth of over 2 feet, for 14 inches through a very compact clay; but in this and other cabbage plants the fibrous roots were found most numerous in the upper 8 inches. The product of a plantation at the Massachusetts State Station is recorded in *R. 1891, p. 196.*

Germination tests of the seed are on record in *N. Y. State R. 1883, p. 69; Ohio R, 1884, p. 198; Ore. B. 2; Vt. R. 1889, p. 105.*

Lacewing fly (*Chrysopa* sp.).—A small four-winged fly, the larvæ of which are quite useful in destroying plant lice and the larvæ of the plum curculio and pear slug. The larva resembles that of the ladybird beetle in shape, but it is differently colored. The fly obtains its name from its delicate wings. (*Mich. R. 1889, p. 251; N. C. B. 78.*)

Lactic acid, effect on churnability of cream.—See *Churning sweet and sour cream.*

Lactocrite for testing milk.—See *Milk tests.*

Lactometer.—See *Milk tests.*

Ladybird beetles.—There are several genera and species of these useful little insects. They may be recognized by their nearly round outline, oval backs, and brilliant colors, usually being red, orange, or yellow, sometimes variously spotted or striped with black. They are seldom over one-quarter of an inch long, and usually less. There are some species of duller color, but of equally great importance. Their larvæ feed exclusively upon plant lice, and aid greatly in destroying them. The larva is longer than the adult, but sometimes resembles it in its marking. (*Mich. B. 51; Miss. R. 1891, p. 34; Nebr. B. 14; N. J. R. 1890, p. 504; N. C. B. 78; Ohio Tech. B. vol. I, 1.*)

Lambs.—See *Sheep.*

Lamb's quarters.—See *Weeds.*

Leaf hoppers.—This name is applied to a numerous class of insects, the more important of which are apple leaf hopper (*Typhlocyba albopicta*), barley leaf hopper (*Cicadula exitiosa*), clover leaf hopper (*Agallia sanguinolenta*), corn leaf hopper (*Tettigonia mollipes*), cranberry leaf hoppers (*Athysanus striatulus, Agallia 4-punctata,* and *Thamnotettix fitchi*), grape leaf or vine hopper (*Typhlocyba vitis*), and rose leaf hopper (*T. rosæ*). These insects are so much alike that a single description will suffice for all. They are about one-tenth of an inch in length and mostly of a yellowish or greenish color. The progeny is abundant and the young resemble the adult, except in size and the lack of wings. They all feed by puncturing the leaf and sucking the sap. When abundant they will cause the leaf to change color and appear as though scalded. The above-mentioned species infest not only the plants from which they obtain their names, but often quite a number of other kinds of plants. When troublesome they may be destroyed by spraying kerosene emulsion over infested plants. Pyrethrum and tobacco infusion are also suggested. If the plants can be covered with a tent or are in a house the fumes of pyrethrum or tobacco will destroy them. Many may be killed by displaying torches at night, by which they may be attracted to vessels containing kerosene. Another method is to hold a large cloth, saturated with tar or kerosene, on one side of the infested plant while the leaf hoppers are driven from the other side. They are easily disturbed and in this way many may be killed.

(*Ark. R. 1889, p. 144; Colo. B. 15; Ga. B. 7; Iowa B. 13, B. 15; Ky. R. 1889, p. 12; Mass. Hatch R. 1888, p. 21; N. J. B. K; N. Mex. B. 2, B. 3, B. 5; Ohio B. vol II, 6, R. 1888, p. 152,*

Leek (*Allium porrum*).—A plantation of 2 varieties of the leek is reported in *N. Y. State R. 1883, p. 184,* and one of 7 varieties in *R. 1884, p. 202.* Most of the latter closely resembled each other. Germination tests of leek seed are reported in *Ohio R. 1885, p. 168; Ore. B. 2; Vt. R. 1889, p. 105.*

Leguminous plants (*Leguminosæ*).—A large class of plants distinguished by the fruit, which is a pod with two valves, the seeds being borne at the inner suture only. Under this name are embraced some 7,000 species of trees, shrubs, and herbs, including many cultivated plants, such as peas, cowpeas, beans, alfalfa, clover, vetches, and lupines. As far as they have been under investigation at the stations these plants are treated in this work under their respective names, but attention will be called here to one characteristic of many leguminous plants which makes them of the highest value to agriculture. Examination of the roots of many species has revealed the presence of gall-like swellings, known as root tubercles. These must be distinguished from the root galls produced by nematodes (*Ala. College B. 9, n. ser.*). Much study of the root tubercles has been made, especially in Europe. As they grow under ground and are opaque it is very difficult to determine just how they are formed. It is now generally agreed that they are not normal products of the plant, but are formed under the influence of microörganisms living in the soil. It is probable but not altogether certain that the microörganisms causing the root tubercles are bacteria. These microörganisms are most abundant in soils in which legumes have previously been grown, and it seems probable that there are different species of bacteria which cause the tubercles on the roots of the different species of leguminous plants.

About ten years ago Prof. Atwater made some experiments at Wesleyan University, Middletown, Connecticut, which showed that peas acquired large quantities of nitrogen from the air. Other experimenters, especially Hellriegel in Germany, pointed out that the acquisition of nitrogen by leguminous plants was connected with the bacteria and root tubercles. Much work on this subject has since been done, and there seems to be no doubt that through the agency of the microörganisms connected with the root tubercles the nitrogen of the atmosphere is made available to many species of leguminous plants. These discoveries are of the highest importance to agriculture. They show that by the growth of leguminous plants the farmer may obtain from the boundless stores of nitrogen in the air a supply which will enable him to raise more abundant and nutritious crops and produce meat which will contain a larger proportion of the elements (protein) that make muscle and give vigor for work. Observations at the Connecticut Storrs Station (*R. 1889, p. 67*) showed that a large proportion of the nitrogen in clover, cowpeas, vetches, and other legumes is contained in the roots and stubble. Such plants may therefore be grown for forage and afterward plowed under to manure the soil for wheat and other crops. The liberal use of leguminous plants for forage and green manuring can not be too strongly urged.

For accounts of inquiries on root tubercles and the acquisition of atmospheric nitrogen in this country see *Conn. Storrs B. 5, R. 1889, p. 67, R. 1890, p. 12, R. 1891, p. 17; Pa. R. 1888, p. 134, R. 1889, p. 177.* Summaries of European investigations on this subject are given in *E. S. R., vol. II, p 686, vol. III, pp. 56, 64, 116, 331, 334, 336, 418, 551, 732, 826, 914, vol. IV, pp. 206, 376, 377, 502, 504, 506.*

Lemon grass (*Andropogon* sp.).—An East Indian grass, the source of a lemon-scented ethereal oil, exported under the name of grass oil. It was found to be hardy at the Berkeley Station, California (*R. 1885–'86, p. 129*), though somewhat stunted out of doors, and it grew luxuriantly in gardens at Santa Barbara. It was thought that it would be successful all along the coast of Southern California.

Lemon (*Citrus medica* var. *limonum*).—Test plantations are noted in *Cal. R. 1890, pp. 294, 300; N. Mex. B. 2.* In *Cal. Sup. R. 1878-'79, p. 60,* the results of acid determinations upon 12 samples of several varieties, made with "standardized" solution of caustic potash, are recorded. Physical analyses and acid and sugar determinations of lemons are given in *Cal. R. 1880, p. 42* (1 sample), *R. 1882, p. 63* (1 sample), *B. 39* (3 samples), *R. 1890, p. 106, B. 93* (3 samples). *See Appendix, Table III.*

In *Cal. R. 1890, p. 106* is reported part of a thorough investigation of the food and fertilizing constituents of citrus fruits. Ash analyses of 2 samples are there given, and a calculation of the fertilizing ingredients consumed by crops of 1,000 and 20,000 pounds. The data available were not regarded sufficiently complete for general conclusions, but the acid percentage, for the Eureka lemon at least, seemed to be unusually high and the sugar percentage relatively large, points favorable to California lemons. But very great differences were found to exist in the proportion of rind to flesh and extractable juice. For an argument in favor of utilizing unsalable limes and lemons in the manufacture of citric acid see *Limes.*

Lentil (*Lens esculenta*).—The lentil is noted in *N. Mex. B. 6* as furnishing seeds "which are of a greenish yellow color, a sorry substitute for beans, but good for soups," and a "fodder or hay made from the vines, when cut and cured in their early growth" which is "highly relished by stock, and for milch cows one of the best." In the soils and climate of that locality it is said to make a large crop of vines and fine seed. It appears also to have yielded well at the Colorado Station (*R. 1890, p. 21*). Germination tests of the seed are noted in *Colo. R. 1888, p. 38; S. C. R. 1888, p. 85.*

Lespedeza (*Lespedeza striata*) [also called Japan clover].—An annual forage plant, native in Asia, and but little known in the United States prior to 1860. Since that time it has widely spread throughout the Southern States and has now become naturalized as far north as the Ohio River. In the South it is preëminently the plant for summer pasturage on sterile clay soils. It will grow where there is not sufficient lime to sustain melilotus. For such soils it is valuable as a renovator. Its growth on poor, dry soil is low and bushy. On rich, moist soil it attains a height of 15 to 20 or even 24 inches, and yields a heavy crop of hay.

Composition.—The pasturage afforded by lespedeza is very nutritious. The hay is rich in albuminoids and is relished by stock. The composition of hay from lespedza grown in Alabama is given as follows: Water, 9.13; ash, 4.11; protein, 13.70; fiber, 21.55; nitrogen free extract, 47.52; fat, 3.99 per cent (*O. E. S. B. 11*).

Culture.—Lespedeza is a tender plant, easily killed by late freezing in the spring and by early frosts in the fall. It has not succeeded in the North (*Iowa B. 11*) and made a growth of only 2 or 3 inches in Nevada (*Nev. R. 1890, p. 14*). It failed in California. It should be sown in the spring after danger from freezing is past. The land may be thoroughly prepared or simply scarified. Sow about 12 pounds of seed and harrow in. The seed is expensive, costing from $4 to $6 per bushel of 25 to 30 pounds. If a heavy crop the first year is not important, 6 pounds of seed will suffice and produce an abundance of seed for the second season. Lespedeza reseeds without care unless too closely pastured. The growing of lespedeza seed for sale is profitable, the yield being about 5 bushels per acre, and the hay remaining after threshing is worth about half as much as when cut for hay alone. To secure the heaviest crop of seed thin sowing is advisable. Lespedeza is never troublesome in cultivated fields as it is easily subdued by the plow. It is aggressive in pastures and meadows and runs out the grasses, hence it is best sown alone or with some winter-growing plant.

Manuring.—On poor ridge land at the Mississippi Station in 1888 a plat fertilized with 200 pounds of plaster yielded 4,380 pounds of hay per acre, while the unfertilized plat afforded a growth too low for mowing; 100 pounds of cotton-seed meal, 100 pounds of acid phosphate, and 30 pounds of muriate of potash, gave the largest yield.

Harvesting.—For a hay crop lespedeza must have good land, which should be made perfectly smooth. Set the mower to cut very close to the ground. Lespedeza

requires very little time in curing, and too much sun will cause the leaves to fall off. The hay is easily handled and is of an attractive green color.

(*Ala. College B. 6; Cal. R. 1890, p. 218; Iowa B. 11; La. R. 1891, p. 11; Miss. B. 20; R. 1888, p. 31, R. 1890, p. 31, Neb. B. 6; N. C. B. 70, B. 73; Tex. College B. 3.*)

Lettuce (*Lactuca sativa*).—Tests of varieties are recorded as follows: *Ala. Canebrake B. 1; Colo. R. 1889, p. 99; Ky. B. 32, B. 38; La. B. 3, 2d ser.; Md. R. 1889, p. 60; Mass. Hatch B. 7; Mich. B. 57, B. 70, B. 79; Minn. R. 1888, p. 260; Nebr. B. 15; N. Y. State R. 1882, p. 136, R. 1883, p. 188, R. 1884, p. 214, R. 1885, p. 132, R. 1886, p. 229, R. 1887, p. 326, R. 1888, p. 122, R. 1889, p. 333; Ohio B. 43; Ore. B. 15; Pa. R. 1888, p. 146, R. 1889, p. 173, B. 10, B. 14; Tenn. B. vol. V, 1; Utah B. 3, B. 12.* The test at the New York State Station in 1885 included 147 nominal varieties, of which 87 appeared to be distinct. These are very fully described and are classified, following Vilmorin under the three heads of cabbage, cos, and cutting lettuce, of which the last was regarded purely artificial. English and foreign synonyms are given with each name and in an index. The next year (*N. Y. State R. 1886, p. 229*) the test covered 70 new names, 60 of the so-called varieties being from Germany and Italy.

Various cultural questions have been somewhat investigated. At the New York State Station (*R. 1884, p. 307*) the rooting habit of lettuce was investigated and found to be strongly downward. A comparative test of mature and immature seed (*R. 1885, p. 137*) showed no great difference in the resulting crops. In *Mass. Hatch B. 4*, directions are given for growing lettuce indoors in such a way as to escape mildew, and remedies for the latter are also prescribed.

In *Ohio B. 43* full directions for greenhouse culture are given, with a list of 40 varieties, characterized in groups and to some extent individually.

In *Mass. Hatch B. 16*, after a general summary of results in electroculture, an account is given of experiments there made in growing lettuce under the influence of dynamic electricity. "Everything considered, the results were in favor of electricity. Those plants subjected to the greatest electrical influence were hardier, healthier, larger, had a better color, and were much less affected by mildew than the others." (See also *Electroculture.*)

Germination tests are reported in *Me. R. 1888, p. 139, R. 1889, p. 150; Mich. R. 1889, p. 18, B. 57; N. Y. State R. 1883, p. 60, 69; Ohio R. 1884, p. 199, R. 1885, pp. 163, 176; Ore. B. 2; Pa. R. 1889, p. 164; S. C. R. 1888, p. 67; Vt. R. 1889, p. 105.*

Lettuce rot (*Botrytis vulgaris*).—Those who raise lettuce in greenhouses for winter market, or in hotbeds for early spring trade, are greatly troubled by their plants rotting before they are half grown. In most cases this is due to the above-mentioned fungus. Its presence on a plant is indicated by a dark-colored decayed spot near the ground. This spreads rapidly, involving the stalk and bases of the lower leaves, drying them up. As the disease progresses the young, tender leaves of the head are attacked, and, decaying, form a slimy mass. If undisturbed, the fungus filaments will soon send their fruiting branches to the surface, where many spores are formed to spread the disease to other plants in the bed. From the nature of this crop, fungicides containing copper can not be employed, and the only means for preventing the spread of the fungus is the removal of diseased plants before they can form their spores. Careful cultivation, so as to secure a vigorous, rapid growth of plants is helpful, and a low temperature will prevent the rapid germination of any spores which may find their way to the plants. Lettuce will grow vigorously in a temperature in which the spores of the fungus will make but little progress, and careful attention to this will aid in saving the crop. (*Mass. State B. 40.*)

Lima bean.—See *Bean.*

Lima-bean mildew (*Phytophthora phaseoli*).—This disease is of comparatively recent discovery (*Conn. State Sta. R. 1889, p. 167*). It first shows itself as a spot having a white, woolly appearance on one side of the unripe pods. This spot extends rapidly during damp weather, penetrating the pod and appearing on both sides; the pod is soon covered with a white, thick, woolly coating. At the same time the pod begins to

decay and finally becomes shriveled and black. The black appearance is not due to this fungus, but to another, for which it has prepared the way. The mildew does not confine itself to the pods, but is found on the young shoots, distorting and checking their growth. Sometimes it is found upon the leaves and leaf stalks. So far it has been confined to Lima beans, but may be found on others. It is recommended that all infected vines and pods be burned to prevent the spread. No doubt the use of some of the common fungicides would tend to repress its attacks, though tests are not reported. (*Conn. State R. 1889, p. 167, R. 1890, p. 97.*)

Lime.—Lime is an essential constituent of all good soils and a prominent ingredient of the ash of all agricultural plants. It is extensively used as a soil amendment and is especially valuable for the renovation of worn soils. Like gypsum, its action as a fertilizer is not well understood, but it probably acts indirectly, rendering available to a certain extent the mineral elements of plant food—potash and phosphoric acid—but being most effective in reducing to assimilable form the inert organic nitrogenous matter of the soil (see *Composts*).

Lime, which is understood to mean quicklime (C_aO), is prepared by burning limestone, shell, or corals until their carbonic acid is driven off. Lime of course varies according to the material from which it is prepared. Good limestone contains 90 to 98 per cent of calcium carbonate with small amounts of magnesia, silica, and iron, and when properly burned will yield a practically pure, rich lime; magnesium limestone, or dolomite, contains carbonate of lime varying from 20 to 80 per cent and carbonate of magnesia varying from 10 to 60 per cent, besides admixtures of silica, iron, and alumina, and yields a poor lime, which slakes slowly, but which has been used with good results as a soil improver (*N. J. R. 1882, p. 40*); oyster shells contain from 85 to 90 per cent of carbonate of lime and yield a good lime. The weight and bulk of different kinds of lime before and after slaking are thus given in *N. J. R. 1882, p. 41:* "A bushel of good stone lime weighs 93 pounds; when slaked it will measure nearly 3 bushels, each of which will weigh about 45 pounds. A bushel of unslaked oyster-shell lime weighs 60 pounds; when slaked it will measure something over 2 bushels, each of which will weigh 40 pounds. A bushel of magnesia stone lime weighs 80 pounds; when slaked it measures about 2 bushels, each of which will weigh 55 pounds."

A product of some agricultural importance is the refuse from gas works known as gas lime. This material is impregnated with sulphur compounds which are injurious to vegetation and it should be allowed to weather before being applied to crops. For composition see *Appendix, Table IV.*

For effect of lime on mechanical condition of soils see *Clay.* For limekiln ashes see *Ashes.*

(*Ala. College B. 3, n. ser.; Conn. State R. 1880, p. 60, R. 1882, p. 50; Md. R. 1891, p. 304; N. J. R. 1881, p. 30, R. 1882, p. 46.*)

Limes (*Citrus medica* var.).—This fruit is mentioned as planted with other citrus fruits in *Cal. R. 1890, p. 300; N. Mex. B. 3.* In *Cal. B. 39* a physical analysis and an acid determination are shown. The acid percentage was 6.86, nearly the same as that of the Lisbon variety of lemons, ascertained at the same time, but the percentage of juice and pulp was considerably higher than that of either of two lemon varieties examined.

In *Cal. R. 1885–'86, p. 77,* occurs an argument in favor of utilizing unsalable limes and lemons in the manufacture of citric acid. The limited market for lime juice seeming to be supplied, the preparation of citric acid in the portable form of citrate of lime is recommended, with which should be combined, when feasible, the manufacture of the essential oil of lemons or of oranges. A process of manufacture is described.

Linden (*Tilia* spp.).—European lindens are named in the tree lists of several stations, and in *Minn. B. 24* it is noted that several varieties had been tried at that station and found too tender. For the American linden see *Basswood.*

Linseed meal.—The linseed meal used in feeding is the ground press cake remaining after the extraction of linseed oil from flaxseed. The old process of removing the oil from the seed was not as thorough as the new process, so that there is considerable difference between the composition of old-process and new-process linseed meal (See *Appendix, Tables I and II*). The new-process meal contains less than half as much fat (oil) and rather more protein than the old-process meal.

LINSEED MEAL FOR MILK AND BUTTER PRODUCTION.—Old and new-process linseed meal were compared at the Massachusetts State Station (*B. 38, R. 1890, p. 15*) as to the quantity and quality of milk produced and the cost. The old-process meal was bought at $27 and the new-process at $26 per ton. The value of the fertilizing ingredients was somewhat higher in the new-process meal, making the net cost of food a little lower than for old-process meal. In general the yield of milk and the percentage of fat in the milk was higher on the old-process meal.

For the result of a comparison of old-process linseed meal with cotton-seed meal and gluten meal by the same station (*B. 41*) see *Cotton-seed meal for milk and butter production.*

Two comparisons of new-process linseed meal with corn meal reported by the Wisconsin Station (*R. 1885, p. 97*) gave opposite results, one showing little, if any advantage, and the other a decided advantage for linseed meal over corn meal. A comparison of linseed meal and wheat bran at the same station (*R. 1886, p. 130*) indicated that pound for pound the linseed meal gave slightly the larger milk production, but assuming bran to cost $12 and linseed meal $25 per ton, bran was much the cheaper food.

The Iowa Station (*B. 14*) observed that "the substitution of bran and oil (linseed) meal for half the amount of corn meal resulted in a marked increase in both quantity and quality of milk, the increase in quality being still more than the increase in quantity."

In a comparison of linseed meal, corn meal, and bran, the New York State Station (*R. 1887, p. 15*) noticed that an increase in the amount of albuminoids fed was favorable to increase in both milk yield and live weight; that the albuminoids in linseed meal seemed to be more especially favorable to increase in live weight, and those in the bran to increase in milk yield. In other words, this experiment indicated wheat bran to be the better of the two for milk production.

The Iowa Station (*B. 16*) made an experiment to ascertain how much linseed meal might be fed without injury, and found that with mature cows 8 pounds per day might be fed, provided the cows were accustomed to it gradually; and that no ill effects resulted from feeding large amounts of linseed meal to pregnant cows. (*N. Y. State R. 1889, p. 198; Vt. R. 1890, p. 88.*)

LINSEED MEAL FOR BEEF PRODUCTION.—As mentioned above, New York State Station (*R. 1887, p. 15*) found that linseed meal was more favorable to beef production than to milk. Linseed meal was fed in a ration with other food to steers at the Massachusetts State Station (*B. 40*).

See also *Cattle, feeding for beef and for growth.*

Liver flukes (*Distomum* spp.).—These parasites infest the livers of cattle, sheep, and goats, the bile ducts being the chief seat of activity. Their bodies are flat, pale brown, irregular, three-fourths to one and one fourth inches long, and one-sixth to one-half an inch wide. A portion of their life cycle is passed in the body of a freshwater snail, and on this account they are more abundant in low-lying localities. The eggs are carried from the bile duct into the intestines and pass from these in the excrement. On falling into the water the eggs hatch and seek the snails, from which the flukes finally emerge to fasten on grass or to float in drinking water, whence they are taken into the bodies of animals. If present in small numbers no serious effect is produced on the health of the animal. If abundant, serious damage results, as they obstruct the flow of bile and the result is a jaundiced appearance of the animal through the presence of bile in the blood. This is continued until the ducts become thickened

and are coated with hard, gritty crusts. The bile undergoes a change and the circulation of the blood is retarded. This results in a dropsical affection either of the abdomen or of the jaw (called "water jaw"). Extreme debility and emaciation, followed often by profuse diarrhea, end the life of the animal. If examined the abdomen or swollen jaw will be found filled with a watery fluid, and the liver will be soft or almost rotted. Eggs of the flukes may be found in the gall bladder, as well as numerous flukes in the bile ducts.

There appears to be no medical treatment of value, although tonics will often give temporary improvement. A liberal use of salt seems beneficial. Cattle having access to salt marshes do not seem to be troubled with flukes to any serious degree. Pure water is an important factor in preventive treatment.

Stock should not have access to stagnant pools in regions known to be infected. (*Ark. R. 1889, p. 109; La. B. 10, 2d ser.; Tex. B. 18.*)

A species described in *Tex. B. 18* under the name of *Distomum texanum* is probably the same as *Distomum magnum* Bassi.

Locusts (*Caloptenus* spp.).—See also *Cicada*. Locusts or "grasshoppers" are so well known as to require no description for their identification. Ordinarily they are not sufficiently abundant to cause any serious injury. However, the migratory ones, commonly called Rocky Mountain locusts, do occasionally become so numerous as to destroy every green thing in their path. Sometimes the other species become troublesome, but not often. They may be killed by scattering the following bait wherever they are abundant: Bran 40 pounds, middlings 15 pounds, sirup 2 gallons, and arsenic 20 pounds. Mix with soft water. They eat this mixture greedily and of course are poisoned. Care must be taken that no domestic animal has access to the places where this mixture is spread. Paris green or kerosene-emulsion sprays may be used. Where present in great abundance the "hopper-dozer" is the best means for combating them. This implement is made of sheet iron 8 or 10 feet long, turned up an inch in front and a foot behind, with pieces soldered in the ends. Hooks are placed in front by which it may be drawn over the ground. If the ground be rough, runners 1 or 2 inches high are advisable. Into this a layer of tar or kerosene and water one-half inch deep is placed and the machine drawn over the infested place. The grasshoppers will jump into the tar or kerosene and be quickly killed. This size may be drawn by two men or boys; larger ones may be made to be drawn by horses. Plowing after the eggs are laid will cover them so deeply as to prevent hatching or the emergence of the young from the ground. (*Iowa B. 14, B. 15; Minn. B. 8, B. 17, R., 1888, p. 305; N. J. B. K.*)

Locust trees.—The black or yellow locust (*Robinia pseudacacia*) "is admired for its racemes of pretty white flowers and graceful foliage," and its wood is valued, but it has been extensively killed by a borer. It is noted in *Minn. B. 24* as "too tender and uncertain over most of this State, and too liable to attacks of borers to warrant its general planting anywhere." In sheltered situations southward in the State it has met with some success. This and the honey locust (*Gleditschia triacanthos*) were planted at the South Dakota Station (*R. 1888, p. 19, B. 12*), but no important results have been reported. "Two or three species" of locust besides the honey locust are noted in *Ala. B. 2, n. ser.* Attention otherwise given to the locust has related to the pests of the first-mentioned species.

London purple.—See *Insecticides*.

Louisiana Stations.—The three stations in Louisiana are organized as a department of the Louisiana State University and Mechanical College, under act of Congress of March 2, 1887. They have the same governing board and director.

SUGAR EXPERIMENT STATION, *Audubon Park, New Orleans*, organized in October, 1885, by the Sugar Planters' Association. The staff consists of the president of the college, director, assistant director, two chemists, sugar-maker, farm manager, and secretary. The principal lines of work are chemistry, field experiments with fertilizers and crops, horticulture, sugar-making, drainage, and irrigation.

STATE EXPERIMENT STATION, *Baton Rouge*, organized in January, 1886, by the State bureau of agriculture. The staff consists of the president of the college, director, assistant director, chemist, assistant chemist, botanist, veterinarian, entomologist, horticulturist, farm manager, secretary, and treasurer. The principal lines of work are chemistry, field experiments with crops, horticulture, diseases of plants and animals, and entomology.

NORTH LOUISIANA EXPERIMENT STATION, *Calhoun*, organized in April, 1888, under act of Congress of March 2, 1887. The staff consists of the president of the college, director, assistant director, chemist, geologist, farm manager, and superintendent of stock. The principal lines of work are field experiments with fertilizers and crops.

Up to January 1, 1893, the three stations had published 4 annual reports and 47 bulletins. Revenue in 1892, $34,900.

Lucern.—See *Alfalfa*.

Lumpy jaw.—See *Actinomycosis*.

Lung diseases.—The principal disease affecting the lungs of hogs is inflammation of the lungs, due to exposure in inclement weather. Careful attention to the feeding, dieting, and comfort of the animal will in most cases effect a cure.

The principal disease of the lungs of sheep is one caused by minute, threadlike worms. The lambs become infected and the worms continue to live and increase, not only in the lungs but in the alimentary canal as well. Preventive measures are best employed. If known to be present in a flock, wean the lambs early and keep them in separate pastures provided with pure water. The symptoms are a dry, husky cough, increased respiration, irregular feeding, and discharge from nose and eyes. If the nasal discharge be examined from time to time the parasites may be found in it. The worms are 1 to 2 inches long and of a whitish color. If the lungs of a dead sheep present a liver-like appearance and sink when thrown into water, this parasite may be looked for in little clusters throughout the lung cavities. Inhalation of chlorine gas or sulphur fumes is recommended as a treatment for this parasite (*La. B. 10, 2d ser.*).

Lupines (*Lupinus* spp.).—A large genus of leguminous herbs or little shrubs, with terminal or axillary racemes of showy flowers. A number of species are grown for ornament. The three species commonly grown for forage are the white (*Lupinus albus*), the yellow (*L. luteus*), and the blue (*L. hirsutus*) lupines. These plants are bushy and somewhat woody, and are generally too coarse for fodder, though used in some countries for sheep. They contain a bitter compound not relished by stock. They are among the plants which collect nitrogen from the air and are valuable for green manuring. (*Conn. Storrs B. 5, B. 6.*)

At the Massachusetts State Station (*R. 1890, p. 172*) it has been found that when lupines are plowed under the first of August, a month afterwards the soil can be worked for seeding down grasses or winter crops.

Colo. B. 12 contains brief descriptions of the native lupines (*Lupinus argenteus* and var. *argophyllus*).

In California (*R. 1890, p. 242*) the sand lupine (*Lupinus formosus*), a large low bush with purple flowers, is a troublesome weed which extends its long, tough rootstocks in every direction, and is difficult to extirpate.

For analyses of white and yellow lupines see *O. E. S. B. 11.*

Lysimeter.—The lysimeter is essentially a rain gauge filled with soil and is used to measure the amount of water which percolates or passes through a soil. In connection with the ordinary rain gauges it should serve to show also the evaporation from the soil. Lysimeters were first constructed in 1796 by Dalton in England. The first instruments were crude affairs, but considerable improvement has been made in their construction, especially by American investigators. The object sought after in every case has been to approximate as closely as possible inside the lysimeter the same conditions which obtain in the surrounding soil. To secure this end unusual pains are often taken to force down the lysimeter box into the soil without in any way

disturbing the inclosed earth (see special report by Levi Stockbridge on investigations with the lysimeter, etc., at the Massachusetts Agricultural College, 1879, and *N. Y. State R. 1882, p.14*).

A decided disadvantage common to all the older forms of lysimeters is thus stated by Dr. Johnson (*Conn. State R. 1880, p. 95*): "The very fact that a stratum of soil is undermined for collecting the water that percolates through it decidedly affects percolation and evaporation—usually diminishes the percolation and increases evaporation by breaking the continuity of the porous earth, which, when continuous, sucks down water from the surface when this is the wetter, and sucks up water from the subsoil when that is the wetter, thus limiting the movement of the water of the soil within a narrower range than it naturally would have."

This statement was confirmed in actual practice at the New York State Station. It was found (*R. 1887, p. 113*) that "the earth within the lysimeter became abnormally dry in times of drought, and on the advent of rain absorbed more water than it would if not thus isolated. The upward movement of the soil water in fair weather being restricted, the soluble soil constituents washed downward faster and appeared in the drainage water in greater proportion than was the case under normal conditions." As a means of approaching the conditions which prevail in natural soil, an instrument was constructed which differed from the ordinary form of lysimeter in being provided with an artificial water table, which is kept at a constant height by the daily addition of sufficient water to make up the loss from evaporation. It is claimed for this lysimeter that it furnishes not only a measure of percolation, but also an approximately correct daily record of soil evaporation. "The conditions within this lysimeter differ from those in the outside soil in the height of the water table being constant. But by providing lysimeters of various depths and by noting the fluctuations in the height of the natural water table, a fair estimate may be formed of the movements of water in the natural soil."

For details of construction see *Ind. R. 1888, p. 21; N. Y. State R. 1888, p. 187.*

Investigations with these instruments have not as yet been fruitful of decisive results. Johnson concludes (*Conn. State R. 1880, p. 95*) from the investigations of Stockbridge, Sturtevant, and others, that with a rainfall of 26 to 44 inches the percolation will amount to 5 to 10 inches. At the New York State Station the percolation through the improved lysimeters described above varied during the months of June–September, 1889, from 24 to 37 per cent of the rainfall. The percolation through the old-style lysimeters during the entire year varied from 38 to 44 per cent of the rainfall, and during the growing season, May–September, from 14 to 23 per cent.

(*Conn. State R. 1880, p. 91; Ind R. 1888, p. 21; Nebr. B. 6; N. Y. State B. 1, R. 1882, p. 14, R. 1883, p. 31, R. 1884, p. 347, R. 1885, p. 293, R. 1886, p. 326, R. 1887, p. 113, R. 1888, p. 313, R. 1890, p. 390.*)

Magnolia (*Magnolia* spp.).—Brief notes are given in *Ala. College B. 2, n. ser.*, on the ornamental and useful characters of the magnolias. The wood is generally soft and not well adapted to cabinetwork, but that of *M. acuminata*, the cucumber tree, is used for pump logs and for making wooden bowls. An investigation of the fuel value of the wood and bark of *M. grandiflora* is recorded in *Ga. B. 3*, with general ash analysis, having especial reference to the manurial value of the ash.

For partial analysis, see *Appendix, Table V.*

Maine Station, Orono.—Organized under State authority March 3, 1885, and reorganized under act of Congress October 1, 1887, as a department of the State College of Agriculture and Mechanic Arts. The staff consists of the president of the college, director, agriculturist, botanist and entomologist, meteorologist, veterinarian, two chemists, horticulturist, assistant botantist and entomologist, assistant horticulturist, foreman of farm, and stenographer and clerk. Its principal lines of work are field experiments with fertilizers, crops, vegetables, and fruits; diseases of plants; digestibility of feeding stuffs; feeding experiments with milch cows and

pigs; and dairying. Up to January 1, 1893, the station had issued 81 annual reports and 30 bulletins. Revenue in 1892, $15,353.

Maize.—See *Corn.*

Malt sprouts.—See *Appendix, Tables I and II.*

Mammitis [also called Garget, or Inflammation of the udder].—A disease of the udder common in cows which are heavily fed at the time of calving. Allowing the milk to remain too long in the udder is a frequent cause of mammitis. The symptoms are swelling of the milk glands, pain in the udder, and fever. The flow of milk is decreased and the cow evinces pain during milking. If not relieved abscesses may form, or a portion of the udder may lose its power of secretion.

The milk should be drawn frequently and hot fomentations applied to the udder, which should be frequently and carefully rubbed with the hand. Some soothing ointment should be rubbed on the udder. The following formula may be used: 8 ounces of vaseline, and 3 ounces each of extract of belladonna, gum camphor, and extract of henbane. If the gland becomes hard, the following ointment may be used: 1 dram each of iodine and iodide of potassium, with 4 ounces of vaseline. To reduce the fever a purgative of Epsom salts may be given. The diet should be light. (*La. B. 10, 2d ser.*)

Mangel-wurzels.—For feeding trials see *Pigs.* For composition see *Appendix, Tables I and II.*

Manure.—Manure, according to Harris, is anything containing an element or elements of plant food, which, if the soil needed it, would, if supplied in sufficient quantity and in an available condition, produce, according to soil, season, climate, and variety, a maximum crop.

The fertilizing materials comprehended in this definition may be conveniently classed in three groups:

(1) Commercial fertilizers (see *Fertilizers*).

(2) Farm manures (see *Barnyard manure* and *Green manuring*).

(3) Soil amendments or improvers (see *Ashes, Gypsum, Lime, Marl, Peat,* etc.).

Maple sugar.—In *Vt. B. 25* preliminary information is given respecting the United States Government bounty upon maple and other sugars reaching a certain standard of purity, together with a report on investigations on maple sugar. Sugar testing 90° or over by polariscope commands a bounty of 2 cents per pound; sugar testing between 80° and 90°, 1¾ cents. The polariscope is explained, but this instrument not being available for farm use, methods of approximate testing by the hydrometer and by the thermometer are described, the latter being preferred as safest, when an accurate thermometer is intelligently used. The main question was how maple sirup must be handled in order to make a sugar testing 80°, and extensive experiments were conducted in sugaring off sirups. A poor sirup requires more heat to reach this test than a good one, and it was found that to make a sugar testing 80° a first-run sirup should be treated to 235° F., the general run of good quality sirup to 235°, and the later runs to 238°. From the last runs a sugar testing 80° cannot be made. Large numbers of samples were sent to the station, generally of ordinary grades, most of which tested over 80°, a few over 90°, and one even as high as 96°. The question is discussed whether it is desirable to gain the highest bounty, *i. e.*, for sugar testing 90°. Since the amount of sugar decreases as the standard rises it would pay only when one can be sure of a correspondingly high price for the high-test sugar. The subject of sirup making is also discussed, and data are given for deciding whether one can more profitably make sirup or make sugar and gain the bounty.

In *Vt. B. 30* the results of the bounty after one year are discussed. It appeared from the returns that 2,328,816 pounds of sugar were weighed and sampled for the bounty, of which 82,237 pounds tested over 90°, 1,939,339 between 80° and 90°, and the remainder below 80°, seven-eighths of the amount thus being entitled to the

higher or lower bounty. The aggregate bounty for the State was $35,094.88. It appeared in general that only those who made some 2,000 pounds of sugar took the steps necessary to secure the bounty. The "relative profit of sugar and sirup" is discussed.

Maple trees. (*Acer* spp.).—The hard or sugar maple (*A. saccharinum,* according to recent authority properly *A. barbatum*) has received considerable attention as a source of sugar, and as a shade and timber tree. In the opinion of the Iowa Station (*B. 16*) "as a combined shade and ornamental tree a well-grown hard maple has no superior." In *Minn. B. 24* it is described as "very hardy over most of the State in heavy, rich lands, when grown in forests, and forming one of our most valuable timber and fuel woods." It does well as a street or lawn tree southward and southeastward in the State, if the trunk is shaded; elsewhere in the State it winterkills badly if exposed, especially when young. In *Mich. B. 39* it is stated that this maple is planted far more abundantly in that State than any or all other trees, deciduous or evergreen; but that a large proportion of the trees die from the attacks of insects. The proper manner of setting and treating the tree is described. The hard maple has been included in the South Dakota (*B. 15*) forestry plantations, but no important results are reported. See also *Ala. B. 2, n. ser.* In *Mich. B. 32* (a report of a forestry convention) occurs a paper upon "The sugar maple in its relation to the forestry question," in which it is argued that within the maple belt no other tree is so well suited to secure the preservation of living forests, on the ground that an immediate and continuous profit is obtainable from making maple sugar. In this paper the tree is not rated high for timber.

The soft or silver-leafed maple (*A. dasycarpum,* according to late authority properly called *A. saccharinum*) has been much planted for shade and ornament, for wind-breaks, etc. (*Ala. College B., 2 n. ser.; Minn. B. 24; Nebr. B. 18; S. Dak. R. 1888, p. 19, B. 12, B. 23.*) By the South Dakota Station (*B. 23*) this is judged, where perfectly hardy, to be as good a rapid-growing tree with soft wood as any available in that State, and a fit substitute for box elder to form the greater part of a grove. "It retains the habit of rapid growth later in life than box elder, but does not endure shade quite so well, and hence is not quite so desirable as a nurse tree." In the central part of the State it winterkills, while young at least, and sends up several shoots from near the ground, necessitating careful pruning. According to *Minn. B. 24* in many parts of the State it is a good street tree, and valued for wind-breaks on account of its quick upright growth." The difficulty that its limbs are liable to be broken by the wind can be largely overcome by shortening the branches. A cut-leafed variety of this species is also noted in *Minn. B. 24.*

The red maple (*A. rubrum*) is briefly described in *Ala. College B. 2, n. ser.* and *Minn. B. 24.* It furnishes a cabinet wood and is used as an ornamental and shade tree.

Other species noted in *Minn. B. 24* are the Norway maple (*A. platanoides*) and the Tartarian maple (*A. tartaricum*). The Norway maple is considered to rival the hard maple in value, but to be a little uncertain in that latitude. Its varieties have special ornamental qualities. The Tartarian is a small pretty tree of promising hardiness, but not long tried.

In *Cal. R. 1890, p. 236,* occurs the following note: "Of the various maples that are native of the country east of the Sierras, none except the *Acer negundo,* or "box elder," has ever equaled (in the State) our native California species. The most valuable of the native species is *Acer macrophylla,* which in suitable soil and within the range of the moist ocean winds is of enduring and rapid growth. It can be highly recommended as an avenue and shade tree. Its timber is also quite valuable.

For ash-leafed maple see *Box elder.*

Marl.—The term "marl" is somewhat indefinite, and in different localities is applied to widely different materials. In a general sense it means essentially a mixture of carbonate of lime and clay with more or less sand, which readily falls to pieces on exposure to the air. Although probably the greater part of the marls found

in this country conform to this definition and depend for agricultural value on their lime content, there are quite extensive deposits of the cretaceous marls known as green sand in New Jersey, which contain considerable amounts of potash (difficultly available) and phosphoric acid, in addition to a variable amount of lime.

Marl beds are widely distributed in the United States and have been developed to a considerable extent in New Jersey, Maryland, Virginia, Kentucky, North Carolina, and South Carolina. The marls of these deposits generally belong to three classes, and occur in geological formations which are found, as a rule, one above the other in immediate succession.

The upper layer, blue or shale marl (neocene), is generally found at or near the surface, and consists chiefly of sea mud with partially decomposed shells and bones. Its value depends mainly upon its content of carbonate of lime (40–50 per cent), although it contains in addition small percentages of potash and phosphoric acid. This class predominates in Maryland, Virginia, and North Carolina, and has been extensively used with good results on worn-out or naturally infertile soils.

The second class, eocene or chalk marl, is commonly "a coarse kind of friable chalk, consisting of comminuted shells and corals of a light yellowish or grayish color to white, sometimes compacted into a pretty solid limestone." Its content of lime is greater (50–95 per cent) than that of the shell marl and the percentages of potash and phosphoric acid less.

In the lower layer occur cretaceous marls known as green sand in New Jersey. These vary considerably in chemical composition and agricultural value. Their fertilizing value is determined chiefly by their content of potash and phosphoric acid, although many are calcareous. The Maryland, Virginia, North Carolina, and South Carolina marls of this class generally average higher in carbonate of lime than those of New Jersey, but New Jersey greensand averages considerably higher in potash and phosphoric acid. This marl has long been used with beneficial results by New Jersey farmers. Their experience has developed the following facts:

Marls containing the most phosphoric acid are the ones which are the most highly esteemed by farmers.

Marls, containing carbonate of lime in fine powder, besides any shells that may be in them, are the best and most lasting fertilizers, though they must be used in large quantities.

Marls, consisting of pure grains of greensand, though containing their full percentage of potash, are frequently without any fertilizing action, and their effects are not very well marked in any cases (*N. J. R. 1882, p. 44*). This is due, probably, to the fact that the potash exists in the form of an insoluble silicate, and is very slowly available to the plant.

If some practicable method of rendering this potash readily available, either by chemical reagents or by composting can be devised, the value of the marl will be greatly enhanced. Work in this line has been undertaken in New Jersey and at the Maryland Station, but as far as known the results have not yet been reported.

In *N. J. R. 1882, p. 43*, it is stated that "greensand marls have been of inestimable value and influence in improving New Jersey agriculture. They have been the means of restoring large districts of worn-out land to fertility; they have improved the texture and productiveness of lands naturally too light to be otherwise worth cultivation; they continue to be used in large quantities, and constitute a valuable low-priced fertilizer, very desirable where the cost of transportation is not too great."

In *N. C. R. 1880, p. 79*, Dr. W. C. Kerr, writing of the use of marl in North Carolina, says: "I have never found a case of its failure to pay, and many worn-out and originally poor farms have been regenerated by its use. The effect of marl is permanent; one good marling will last two generations and more."

Although such favorable results follow the use of marls on land in close proximity to the deposits it must be borne in mind that only in very rare instances do these marls furnish sufficient plant food to pay for costly manipulation or extended transportation.

The value of marls as fertilizers was early appreciated by the farmers of eastern Virginia, and Edmund Ruffin, in his work on Calcareous Manures, published in 1832, describes the nature of the marl deposits of that part of the State and discusses fully the principles and practice of marling as then understood.

The wide variations in composition of different marls are shown in the following table:

	Potash.	Lime.	Phosphoric acid.
	Per cent.	*Per cent.*	*Per cent.*
New Jersey green sand	3.53–7.00	1.26– 9.07	1.02–3.87
Maryland marls	0.24–4.76	trace–39.90	trace–1.74
North Carolina marls	0.25–1.50	5.00–45.00	0.10–10.00
Kentucky marls	0.18–3.12	0.37–33.96	trace–0.36

(Ala. College B. 8, n. ser.; Cal. R. 1890, p. 83; Canada Expt. Farms R. 1889, p. 42, R. 1890, p. 112; Conn. State B. 36, B. 53, R. 1879, pp. 43, 46, R. 1882, p. 52, R. 1884, p. 75; Ky. B. 39; La. B. 25, B. 1, 2d ser.; Md. R. 1889, p. 79, R. 1890, p. 119, R. 1891, p. 298; Mich. B. 9; Miss. B. 4, R. 1890, p. 38; N. J. R. 1880, p. 37, R. 1881, p. 28, R. 1882, p. 43; N. C. R. 1883, p. 96, R. 1884, p. 84, R. 1885, p. 73. R. 1887, p. 50, R. 1888, p. 41; Tenn. B. vol. II, 1; Tex. B. 13; Vt. R. 1889, p. 36.)

Martynia (*Martynia proboscidea*) [also called Devil's claws or Unicorn plant].—A wild plant in the South and West, the young green fruit of which is used for pickles. "The ripe pods are black, hard, and horny, and provided with two long hooked beaks or claws. The flower resembles somewhat that of a catalpa, to which it is closely related." It has been grown at the Minnesota (*R. 1888, p. 258*) and Nebraska (*B. 12*) Stations.

Maryland Station, College Park.—Organized under act of Congress March 9, 1888, as a department of Maryland Agriculture College. The staff of the station consists of the president of the college, director, chemist, agriculturist, horticulturist, physicist, assistant agriculturist, treasurer, and stenographer. Its principal lines of work are chemistry, field experiments with fertilizers, field crops, vegetables, and fruits. Up to January 1, 1893, the station had published 4 annual reports and 28 bulletins. Revenue in 1892, $15,000.

Massachusetts Hatch Station, Amherst.—Organized under act of Congress, March 2, 1888, as a department of the Massachusetts Agricultural College. The staff consists of the president of the college and director, agriculturist, horticulturist, entomologist, meteorologist, two assistant horticulturists, assistant agriculturist, treasurer, and auditor. The principal lines of work are meteorology, field experiments with fertilizers and fruits, and entomology. Up to January 1, 1893, the station had published 4 annual reports and 68 bulletins Revenue in 1892, $15,000.

Massachusetts State Station, Amherst.—Organized under State authority, July, 1882. The staff consists of the director and chemist, mycologist, five assistant chemists, assistant in field experiments and stock feeding, and foreman. The principal lines of work are chemistry, analysis and control of fertilizers, field experiments with fertilizers and field crops, diseases of plants, analyses of feeding-stuffs, and feeding experiments. Up to January 1, 1893, the station had published 9 annual reports and 45 bulletins. Revenue in 1892, $13,600.

May beetle (*Lachnosterna fusca*) [The adult insect is also known as June bug and its larva as White Grub or Grub-worm].—A very common beetle, three-fourths of an inch long, dark brown or black. The beetles rest during the day and feed at night on the leaves and fruit of the trees. The eggs (40 to 60 in number) are deposited in the ground in a ball of earth, and soon after the female dies.

The larvæ live for three years in the ground. The grub is soft, white with brownish head, and has six legs well toward the front of the body. The beetles may be treated

with arsenites or they may be jarred from trees early in the morning. Plowing and exposing the grubs to birds will cause the destruction of many. They are also held in check to a considerable degree by natural enemies.

Rapid rotation and high cultivation of crops are unfavorable for grubs.

(*Ark. R., 1890, p. 70; Ky. B. 31; Me. R. 1889, p. 189; Mass. Hatch B. 12; N. Mex. B. 2; Ohio B. vol. III, 4; Vt. R. 1889, p. 156; W. Va. R. 1890, p. 155.*)

Meadows.—The grasses best suited for meadows in Minnesota are discussed in *Minn. B. 12.* Grasses and clovers sown in the spring with a small grain crop should have a hard, fall-plowed seed bed. If the soil is wet and heavy, harrowing should be very light, but if the land is dry it may be thorough. Permanent meadows are not considered as profitable as short rotations of meadow and cultivated crops. For wet lands, a mixture of redtop and alsike clover is recommended. The latter makes a good growth in the first few years while several years are required for the best results from redtop. For this reason redtop does not find a place in short rotations. The cost of orchard-grass seed, from \$3 to \$5 for the 3 bushels necessary to an acre, practically excludes this grass from a short rotation. Timothy fits into rotation well, but alone it "serves for only a few years in a permanent pasture or meadow." Blue grass in Minnesota grows too short for meadows.

In choosing a field for a permanent meadow it is well to avoid dry, sandy, or gravelly soil.

At the Michigan Station (*B. 77*) recently seeded meadows yielded more hay than those which had been in grass and pastured for about twenty-five years. The following plants were sown alone: Meadow fescue, meadow foxtail, tall oat grass, redtop, June grass, orchard grass, alfalfa, *Agropyrum tenerum*, fowl meadow grass, taller meadow fescue, timothy, red and mammoth clover. Meadow fescue and perennial rye grass were sown together. The yields made by these two were compared with the hay from a mixture of timothy, tall oat grass, orchard grass, tall fescue, fowl meadow grass, red clover, mammoth clover, and *Agropyrum tenerum*. The mixture afforded by far the largest crop.

The Massachusetts State Station (*R. 1891, p. 184*) condemns the seeding down of grasses in the spring in Massachusetts. On the other hand, in Kansas (*B. 2*) it has been found best to sow in the spring, not earlier than April 15. On the Kansas Station farm a mixture of orchard grass (2 bushels per acre) and red clover (3 quarts) has proven more satisfactory than any other combination.

Medlar (*Mespilus germanica*).—A small tree and its fruits, related to the crab apple, somewhat cultivated in Europe but rarely in this country. The fruit is edible only in the early stages of decay. A plantation of three varieties is noted in *La. B. 3, 2d ser.*

Melilotus (*Melilotus alba*) [also called Bokhara clover and Large white clover].—Uses.—Melilotus resembles alfalfa, but grows much taller (3 to 8 feet) and bears a number of small white flowers. It is a biennial but will reseed itself indefinitely. It thrives on calcareous soils, making some growth even on the bare rotten limestone, where no other plant could subsist. On the black prairie soils of the South and on yellow loam and white lime soils it has a high va ue as a renovating crop. These black prairie soils, most of which do not respond to commercial fertilizers, are easily improved by seeding to melilotus. The decay of the large roots not only supplies plant food, but by leaving numerous small holes in the soil aids in the drainage. Melilotus is valuable both for pasturage and for hay. At first animals refuse to eat it, but later relish it. It makes an early spring growth and remains green late in the fall. In Nevada melilotus grew well along streams but did not thrive in dry situations.

On the lime lands of the South, for early and late pasturage and for restoring the fertility of exhausted fields, it has no superior among the clovers. When cut early it is a valuable hay crop, but in this respect is surpassed by lespedeza and red clover. Though melilotus grows on lime soils North and South, it has been appreciated

chiefly in the South. In some States farther north it is considered a weed. As a renovating crop it merits trial on calcareous soils in every latitude. Melilotus has also some value as a bee plant. It has been tested at the Massachusetts State Station, giving a smaller yield of hay than timothy. The best reports come from the Mississippi and Alabama Canebrake Stations, where the land is highly calcareous. At the Mississippi Station it thrives best on soil richest in lime—where the rotten limestone is near the surface—making less thrifty growth on clay hills and rich bottoms.

COMPOSITION.—For composition see *Appendix, Table II.*

CULTURE.—February and March are the best months for sowing. From 2 to 4 pecks of seed per acre should be sown broadcast. A smaller amount of seed will give a smaller crop the first year, but will suffice if the plant is allowed to reseed itself. Sow the seed on well prepared land and the winter rains will cover it. Or if the land is not in good condition, harrow after sowing. Melilotus may be sown with oats in February or the seed may be scattered over a field of fall sown oats.

HARVESTING.—During the first season one or two cuttings may be made; during the second season two or three. If the land is to remain in melilotus more than two years, only two cuttings are made the second season, after which there is usually sufficient seed formed to insure a stand. It is important that melilotus be cut before the stalks become coarse and woody. From 15 to 20 inches is the best height. The first cutting of the second season is secured about May 1. Melilotus produces a heavy growth of hay, which, though excellent for home use, is not so salable as lespedeza hay.

Melilotus must be cured with care, as too much sun causes shedding of the leaves. At the Massachusetts State Station it produced at one cutting 3,090 pounds of hay per acre the first season; its yield is much heavier the second season.

ROTATION.—Corn, cotton, and oats all succeed well on a field that has been in melilotus two years. Such a rotation sometimes increases the corn crop from 10 or 15 to 25 or 30 bushels per acre and upwards. When it is desired to run the land in melilotus more than two years, seeds must be allowed to form, and these may be left as they fail, or the land may be harrowed.

(*Ala. Canebrake B. 7, B. 9, B. 10, B. 11, B. 13, B. 14; Colo. B. 2; La. B. 26, R. 1891, p. 11, Me. R. 1889, p. 161; Mass. State R. 1890, p. 161, R. 1889, p. 294; Mich. B. 68; Miss. B. 20, R. 1889, p. 33, R. 1890, p. 31; Nev. R. 1890, p. 15; N. C. B. 73; Tex. B. 3.*)

Meteorology.—More or less extensive meteorological observations have been reported from the following experiment stations: Alabama, Colorado, Connecticut Storrs, Delaware, Georgia, Indiana, Kansas, Louisiana, Maine, Maryland, Massachusetts Hatch, Massachusetts State, Michigan, Mississippi, Missouri, Nebraska, Nevada, New York State, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Texas, Utah, Virginia, West Virginia, Wisconsin, and Wyoming. A meteorologist is employed at thirteen stations.

In many cases only the simplest observations—temperature, precipitation, etc.—have been attempted, in others records are kept of barometric pressure, precipitation and temperature at different heights; direction, velocity, and pressure of the wind; percentage of cloudiness, classification, movement, and direction of clouds; amount of sunshine and sun temperatures; atmospheric electricity, frosts, dews, halos, coronæ, storms, and other natural phenomena.

Some of the stations, notably those of Alabama, Indiana, and North Carolina, have organized comprehensive weather services, coöperating with the Weather Bureau of the U. S. Department of Agriculture, and efforts are being made to extend this coöperation.

The Massachusetts Hatch Station is especially well equipped for meteorological work. It is supplied almost exclusively with self-recording instruments, including some of the most expensive and delicate apparatus used for meteorological investigations in this country (*Mass. Hatch R. 1889, p. 6, R. 1890, p. 8*).

The Alabama College and North Carolina Stations have issued full reports on the climatology of those States based on observations running back, in the first case seventy to eighty years, in the second, seventy-two years (*Ala. College B. 18, n. ser.; N. C. Special R. 1891.*

Meteorological articles of special interest which have appeared in station publications are: Origin of Cold Waves (*N. C. Met. R. 1890, p. 72*); Protection from Frosts (*Minn. B. 12*); The Formation and Classification of Clouds (*N. C. Met. R. 1890, p. 68*); and a General Sketch of the Climate of North Carolina (*Special R. 1891, p. 157*).

Mexican clover (*Richardsonia scabra*).—This plant, though not a clover, bears some resemblance to the clovers in its habit of growth. It has become naturalized along the coast of the Gulf of Mexico. It prefers a sandy soil, coming up in cultivated fields after crops are laid by. The yield of hay is from 1 to 2 tons per acre. This is an annual plant and is not suitable for pastures. (*Ala. College B. 6, n. ser.; Miss. R. 1889, p. 34, R. 1890, p. 32.*)

Michigan Station, Agricultural College.—Organized under act of Congress Febary 21, 1888, as a department of Michigan Agricultural College. The staff consists of the president of the college and director, agriculturist, chemist, botanist, zoölogist, horticulturist, veterinarian, secretary and treasurer, assistant to director, three assistant agriculturists, two assistant horticulturists, two assistant chemists, and librarian. Up to January 1, 1893, the station has published 4 annual reports and 89 bulletins. Revenue in 1892, $16,054.

Middlings.—See the articles on the feeding of different kinds of animals. For composition see *Appendix, Tables I and II.*

Mignonette leaf blight (*Cercospora resedæ*).—A fungous disease which often causes the loss of many mignonette plants. It appears either as small sunken spots, rather pale in color with a brownish border or as reddish discolorations, more or less involving the leaf, upon which are finally developed the pale spots or patches. The disease spreads very rapidly, and the dead areas increase in size and become irregular in shape, the leaves curl, wither and hang lifeless on the stem, and in ten or twelve days the plant looks as though suffering badly from drought. Early and repeated application of Bordeaux mixture has been proved a successful remedy for this disease. (*N. J. R. 1890, p. 363.*)

Milk.—The work of the stations on milk will be treated under the following heads: (1) Properties and composition, (2) creaming, (3) skim milk, (4) serving to customers from cans, (5) basis of selling at creameries and cheese factories, (6) secretion, and (7) effect of food on yield and composition. (See also *Milk fermentations, Milk tests*, and *Milking.*)

Properties and composition.—Milk is the secretion of the mammary glands of the females of the mammalian group. It is an opaque, bluish-white fluid consisting primarily of about 87 per cent water and 13 per cent solids. The solids include fat, which is separated in butter-making, casein, which is of importance in cheese-making, milk sugar, and ash, together with traces of other substances. The fat exists in the form of minute globules, varying considerably in size, which are held in suspension in the milk. The casein is a nitrogenous material belonging to the same class of compounds as egg albumen. The casein, milk sugar, and ash are dissolved in the water and constitute the milk serum in which the fat globules are suspended. The curdling of milk is due to the coagulation of the casein. The souring is due most frequently to fermentative changes which take place in the milk sugar, resulting in the formation of lactic acid, which in turn causes the casein to coagulate, *i. e.*, the milk to curdle. Milk is subject to numerous other fermentative changes not mentioned here, which are reviewed in Experiment Station Bulletin No. 9, of the Office of Experiment Stations, U. S. Department of Agriculture (see *Milk fermentations*).

The ash contains the mineral ingredients of milk, as potash, soda, phosphates, lime, magnesia, traces of iron, etc. According to Babcock, of the Wisconsin Station, milk contains a material called fibrin, which coagulates after the milk is drawn, forming a network of fine elastic fibers (see *Creaming of milk*). The composition of cows' milk varies quite widely with the breed, stage of the milking period, character of food, etc. An average composition may be given as follows: Water 87, fat 4, casein and albumen 3.4, milk sugar 4.9, and ash 0.7 per cent.

Fat globules.—An idea of the minuteness of the fat globules of cows' milk may be gained from the statement that twenty-five average globules placed side by side would be about equal to the thickness of ordinary writing paper, and that a pint of milk contains not far from a million globules. The size of fat globules, however, is far from being constant, varying with the breed, the stage of the milking period, health of the cow, and other things. It is characteristic of the fat globules of Jersey and Guernsey milk to be relatively large and quite uniform in size, while those of the Ayrshire and Holstein milk are small. For instance, the New York State Station found the proportion of fat globules over three divisions of the micrometer scale in diameter to be as follows: Jersey milk 70 per cent, Guernsey milk 55 per cent, Devon and American Holderness milk 35 per cent, Ayrshire milk 24, and Holstein milk only 11.3 per cent. The fat globules diminish in size as the period of lactation advances, which accounts for the decrease in yield of fat; the New York State Station found that the number of globules actually increased as the milking period advanced. Dividing the milking period into four parts it was found on an average for a large herd that the relative number of globules was 100 in the first quarter, 139 in the second quarter, 149 in the third quarter, and 189 in the fourth quarter. That is, the whole amount of milk given in the last quarter contained 89 per cent more fat globules than that given in the first quarter. The same station found in a trial in which five cows were milked that both the total number and the number of large globules in the milk from a milking increased with the successive portions drawn.

The question of the size of fat globules is an important one in connection with butter-making (see *Creaming of milk*).

Studies on fat globules have been reported as follows: *Ind. B. 24; N. H. R. 1888, p. 84; N. Y. State R. 1885, p. 266; N. Y. State R. 1891, p. 143; Me. R. 1890, p. 58; Vt. R. 1890, p. 65; Wis. R. 1890, p. 238.*

Investigations by Babcock (*N. Y. State R. 1885, p. 274*) pointed toward a relation between the melting point of butter fat and the size of the globules.

Composition.—The New York State Station (*R. 1891, p. 141*) analyzed the milk of six breeds of cows during one period of lactation, with the following average results:

Average composition of milk of different breeds.

Breeds.	No. of analyses.	Water.	Total solids.	Fat.	Casein.	Milk sugar.	Ash.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Holstein-Friesian	132	87.62	12.39	3.46	3.39	4.84	0.735
Ayrshire	252	86.95	13.06	3.57	3.43	5.33	0.698
Jersey	238	84.60	15.40	5.61	3.91	5.15	0.743
American Holderness	124	87.37	12.63	3.55	3.39	5.01	0.698
Guernsey	112	85.39	14.60	5.12	3.61	5.11	0.753
Devon	72	86.26	13.77	4.15	3.76	5.07	0.760
Average of all	....	86.37	13.64	4.24	3.58	5.09	0.731

By averaging over 2,400 American analyses the Vermont Station (*R. 1890, p. 97*) found the relation of the solid ingredients to each other in milk containing different percentages of total solids to be as follows:

Relation of milk constituents in total solids.

Percentage of total solids.	In 100 parts of total solids.		
	Fat.	Casein.	Milk sugar and ash.
11	28	26	46
12	29	25	46
13	31	25	44
14	33	25	42
15	36	26	38
16	38	26	36

It will be noticed that the casein remains about one-fourth of the total solids, while the fat increases proportionally as the total solids increase. See also *N. Y. State R. 1891, p. 139; Wis. R. 1886, p. 159.*

The milk from the first portion of any single milking is relatively poor and increases in richness to the strippings, which are relatively very rich. Thus the New York State Station found that in the case of five cows the first pint of milk contained only 0.3 per cent of fat, while the last pint contained 6.85 per cent, and the mixed milk from the whole milking averaged 2.55 per cent. In every instance the first half contained only from one-third to one-half as much fat as the last half. Similar results are reported in *Conn. State R. 1891, p. 114.* (See also *Ind. B. 24; N. H. B. 9.*)

Variation in quality.—The milk of the same cow differs both in composition and in yield from day to day. Babcock states that yield may vary by 15 per cent and the amount of fat by as much as 50 per cent. Four cows tested at the Wisconsin Station (*R. 1889, p. 42*) showed an average daily variation of from 1.18 to 1.8 pounds of milk; and the yield of fat per day fluctuated about 8 per cent. (*Ill. B. 17.*)

The manner of milking also affects the composition of the milk. It was found that cows which ordinarily gave milk with 4 and 5 per cent fat, respectively, gave milk with only 2.7 and 3.92 per cent, respectively, when milked one teat at a time. The milk was richer in fat when milked rapidly (3 to 4 minutes) than when milked slowly—double that time—though the yield seemed not to be affected (*Wis. R. 1889, p. 44*).

The Wisconsin Station (*R. 1889, p. 42*) found that change of milker, manner of milking, and change of environment all exert a more or less decided influence, temporarily at least, on the quantity and quality of the milk produced, the fat being, as a general rule, more sensitive to such changes than the other ingredients or the total yield of milk (see *Milking*). The Vermont Station (*B. 22*) found that some cows made a better showing at fair grounds than at home and others *vice versa*, but in all cases the fat was the ingredient most subject to variation.

The excitement attendent upon dehorning also has different effects upon the milk of individual cows. Often cows in the same barn which were not dehorned showed the effects on yield and composition of milk quite as much as those dehorned. In all cases the effects were only temporary, lasting from one to five days. In general, the fat was the ingredient most likely to be affected, and this, together with the yield of milk was slightly diminished. (*Ark. R. 1888, p. 22; Minn. B. 19, p. 3; N. Y. Cornell B. 37; Wis. R. 1888, p. 142, R. 1889, p. 57.*)

For effects of spaying cows see *Spaying*.

As the milking period advances the milk yield diminishes and the percentage of solids increases, that is, the milk becomes richer. The indications are that this increased richness is confined almost wholly to the fat, and that there is little variation in the percentage of solids not fat. (*N. H. B. 9; N. Y. State R. 1891, p. 105.*)

Morning's and evening's milk.—As regards the composition of the milk secreted during the day and that secreted during the night, analyses of a large number of samples at the New York Station (*R. 1890, p. 14*) showed very little difference,

although the night's milk contained on an average slightly more water. The quantity of milk secreted per hour was practically the same during day and night, but the amount of fat secreted averaged 11½ per cent more during the day than during the night.

The New Hampshire Station (*B. 9*) found that while cows were at pasture the morning's milk was richest in fat, but when they were kept in the barn the night's milk was richest. Thus, the average percentage of fat in the milk of one Jersey cow during June, July, and August was: Morning's milk 6.26, night's milk 5.75; and during January, February, and March: Morning's milk 5.81, night's milk 6.30. "Other cows gave corresponding results."

The Maine Station (*R. 1887, p. 117*) found as the average of two years that in winter the morning's and night's milk of Jerseys differed but little, but that with Ayrshires the morning's milk was better than the night's by a small constant difference. "The mixed milk of common cows during June and July contained 0.51 per cent more solids and 0.60 per cent more fat in the morning than at night."

At the Mississippi Station (*B. 13*) it was found that when cows were milked at between 5:30 and 7 in the morning and between 3:30 and 5 in the afternoon, it required on an average 18.1 pounds of the morning's milk and only 13.5 pounds of the night's milk to make a pound of butter.

For effect of warm *vs.* cold water see *Cows, warm vs. cold water.*

For fibrin in milk see *Creaming of milk.*

For effects of time of milking, intervals between milking, manner of milking, and thorough milking, see *Milking.*

As to the rate of decrease in milk yield with the advance of the period of lactation, Dr. Sturtevant gives (*N. Y. State R. 1886, p. 26*) a table based on the averages for 35 native cows and 59 calvings, 45 Ayrshire cows and 145 calvings, and 3 Jersey cows and 6 calvings, representing in all 83 different cows and 210 calvings.

Babcock has studied the viscosity of milk in its relation to creaming and churning qualities, etc., and has devised a viscometer for determining the viscosity of emulsions. (*N. Y. State R. 1886, p. 297.*)

Analyses of milk have been reported, among others, in the following publications: *Ala. College B. 25, n. ser.; Ark. B. 12, R. 1889, p. 5; Conn. State R. 1891, pp. 96, 112; Del. R. 1889, p. 164; Ill. B. 9, B. 16; Ind. B. 24; Iowa B. 8, B. 11, B. 14; Kans. R. 1888, p. 69; Ky. B. 3, Mass. State B. 32, B. 38, R. 1888, p. 11, R. 1889, pp. 12, 48, R. 1890, p. 39, R. 1891, p. 299; Mass. Hatch. R. 1891, p. 11; Me. R. 1885–'86, p. 65, R. 1890, p. 17; Mich. B. 68; Miss. B. 15; N. H. B. 9, R. 1888, p. 69, R. 1889, p. 69; N. J. B. 61; N. Y. Cornell B. 13, B. 17, B. 22, B. 25, B. 29; N. Y. State B. 34, n. ser., R. 1890, pp. 10, 171, R. 1891, p. 232; Pa. B. 12, R. 1888, pp. 55, 95; Tex. B. 14; Vt. B. 22, R. 1889, p. 51, R. 1890, p. 107; Wis. B. 18, B. 24, R. 1888, p. 28, R. 1890, p. 114.*

Milk of different breeds: *Ill. B. 9, B. 12; Mass. Hatch R. 1891, p. 11; Me. R. 1890, p. 17; Mich. B. 68; N. H. B. 9; N. J. B. 65, B. 77; N. Y. State B. 34, n. ser., R. 1890, p. 171; Wis. R. 1889, p. 115.*

Milk from different teats, *Wis. R 1889, p. 44.*

Mineral ingredients of milk.—Analyses of the ash of milk have been reported by the Maine (*R. 1890, p. 52*) and New Hampshire (*R. 1888, p. 89*) Stations. These are tabulated below, showing the percentage of mineral ingredients in 100 parts of ash, The analyses of breed milk are by the Maine Station and the mixed herd milk by the New Hampshire Station.

Analyses of ash of milk.

	Potassium oxide.	Sodium oxide.	Calcium oxide.	Magnesium oxide.	Oxide of iron.	Phosphoric acid.	Sulphuric acid.	Chlorine.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Jansje, Holstein	26.49	8.88	21.94	3.25	0.44	26.11	2.43	13.49
Agnes Smit, Holstein	27.23	9.37	19.65	2.47	0.42	29.63	1.41	12.68
Nancy Avondale, Ayrshire	18.80	11.72	26.85	3.10	0.39	25.52	3.21	13.44
Queen Linda, Ayrshire	25.97	7.62	24.05	2.34	0.19	30.31	1.38	10.51
Agnes, Jersey	21.65	7.79	25.58	2.50	0.46	31.41	2.70	10.21
Ida, Jersey	23.94	8.94	22.13	2.59	0.20	32.97	0.93	10.71
Herd milk	27.83	8.65	21.05	1.67	....	25.34	....	14.83

The amount of fertilizing ingredients contained in 1,000 pounds of cows' milk has been variously calculated as follows:

Fertilizing ingredients in 1,000 pounds of whole milk.

	Potassium oxide.	Phosphoric acid.	Nitrogen.*
	Pounds.	*Pounds.*	*Pounds.*
Holstein milk, Maine Station	1.69	1.74	Not det.
Ayrshire milk, Maine Station	1.47	1.85	Not det.
Jersey milk, Maine Station	1.74	2.46	Not det.
Mixed milk, New Hampshire Station	2.09	1.90	4.80
Mixed milk, New York State Station	1.69	3.00	7.00
Mixed milk, New York State Station	1.45	2.45	5.45

*Principally as casein.

(*N. H. R. 1888, p. 89; N. Y. State R. 1889, p. 208; Me. R. 1890, p. 52.*)

MILK, CREAMING.—See *Cream* and *Creaming of milk.*

SKIM MILK.—See also *Butter-making.* For the value of skim milk for feeding see *Cattle, feeding for beef and for growth,* and *Pigs, feeding.*

It is the fat chiefly which rises to the surface of milk in creaming and is removed in skimming; consequently the composition of the skim milk will largely depend upon the efficiency of creaming. The casein, milk sugar, and ash nearly all remain in the skim milk. The fat which remains consists very largely of small globules which failed to separate or rise as soon as the others. The fat in skim milk may be as high as 1 per cent or even more by inefficient methods of creaming and less than 0.1 per cent by centrifugal creaming. Seventy six samples of skim milk from various sources which were analyzed at the Massachusetts State Station (*R. 1891, p. 337*) showed the following average composition: Water 90.5, solids 9.50, fat 0.45, and casein 3.53 per cent.

A compilation of American analyses prepared by the Vermont Station (*R. 1891, p. 119*) showed the following average composition:

	Per cent.
Total solids	9.75
Fat	0.30
Casein	2.75
Albumen	0.75
Milk sugar	5.15
Ash	0.80

Other analyses of skim milk are reported in *Me. R. 1890, p. 33; N. Y. State R. 1890, p. 172.* The fertilizing ingredients were: Nitrogen 0.56 per cent, phosphoric acid

0.2 per cent, and potassium oxide 0.185 per cent. At current prices of fertilizer ingredients in the East this would give a value of about $2.30 per ton for the fertilizing ingredients of skim milk.

MILK, SERVING TO CUSTOMERS FROM CANS.—It has been claimed that serving milk by drawing from the bottom of a can by a faucet and by dipping from the top of the can both result in injustice to the customers, owing to the rise of the cream in the can during delivery.

The New York Cornell Station (*B. 20*) has made a comparison of the composition of the milk served to successive customers along the route by dipping from the can with an ordinary dipper. It was found that with no other agitation of the milk than that due to the motion of the wagon and the dipping "substantial justice is done all the patrons as far as the amount of fat apportioned to each is concerned."

In this connection may be noted observations by the Ontario Agricultural College Station (*B. 66*) on the composition of milk served by drawing through a faucet at the bottom of the can. There was found to be practically no difference in the percentage of fat in successive portions drawn from the same can.

MILK, BASIS OF SELLING AT CREAMERIES AND CHEESE FACTORIES.—See *Creameries, Cheese factories*, and *Milk tests.*

MILK, SECRETION.—The New York State Station has studied the secretion of milk by fifteen cows representing six breeds during one period of lactation. When the cows were milked at 5 a. m. and 5 p. m. the average amount of milk secreted per hour was 0.7 pound during the day and 0.696 pound during the night, or practically the same for day and night. As mentioned elsewhere, they found practically no difference between the composition of mornings' and nights' milk, the nights' milk averaging only 0.14 per cent more water than the mornings' milk. It was calculated from this and from determinations of the number of fat globules in milk that there were secreted each second on an average nearly 136 million globules of fat.

As mentioned on page 204 the percentage of fat increases as lactation advances, while the solids not fat remain practically stationary; the solids increase in any single milking from the portion drawn first to the strippings and the indications are that "the differences in the successive portions of milk drawn are almost wholly in the relative amount of fat they contain;" and the fat is more subject to change than the other milk ingredients from conditions affecting the animal, as dehorning, etc.

It has been claimed that the amount of fat in cows' milk was much greater than could be accounted for by the amount of fat contained in the food eaten. The New York State Station found that the total amount of crude fat consumed by fifteen animals during nearly one period of lactation was 4,587.9 pounds and the total amount of fat produced in the milk was 3,793.4 pounds. When the cows were fresh in milk the production of fat exceeded that consumed in the food, but very soon these became equal, and in the latter part of the milking period the amount consumed was in excess of that produced. The indications from this are that whether or not the milk fat is derived wholly or in part from the fat in the food, ordinarily the food contains enough fat to equal that produced in the milk. (*N. H. B. 9; N. Y. State B. 24, R. 1884, p. 61, R. 1891, pp. 121, 155; Wis. R. 1889, p. 61.*

MILK, EFFECT OF FOOD.—The question of the effect of food upon the yield and composition of milk is one which has called forth a variety of opinion and much experimental work. It is held by many that food is, after all, of only secondary importance, and that much more depends upon the qualities of the animal itself, the size of the milk glands and the capability of the latter for producing milk. At the same time a certain amount of food is of course necessary to keep up the secretion. The belief is prevalent among farmers that the character of the food or the proportion of food ingredients it contains directly or indirectly influences the milk secretion, and this belief is borne out by the results of some feeding experiments in this country and abroad. The effect of food on the milk secretion may make itself apparent in several ways. (1) The quantity may increase or decrease, resulting

in a more or less watery milk; (2) the quantity of milk yielded may increase or decrease without any change in the composition of the milk; (3) the proportion of solids to water may change without any change in the quantity of milk yielded, also resulting in a richer or poorer milk; (4) the milk may become richer in respect to a single milk ingredient without a change in the other solids; and finally (5) the taste of milk may be affected. The first case involves a change in the water content alone. The second and third cases involve an increased or diminished production of solid ingredients by the milk glands. The fourth case involves increased production of a single milk ingredient without a corresponding increase of the others. The fifth case is generally supposed to result from the transmission of qualities from the food to the milk. It has recently been contended by a prominent authority abroad that the composition of milk is less subject to change as a result of feeding than is usually supposed to be the case and that grain or rich food added to a ration which already meets the food requirements of the animal does not influence the composition of the milk, although it may increase the yield of milk. The change in the relation of the different ingredients of the milk solids to each other, that is, a one-sided increase in the percentage of a single ingredient, has been noticed in only a few isolated cases and the ability to induce such a change appears to be characteristic of only a very limited number of foods.

Numerous and varied feeding experiments with cows have been made at our stations and the results of some of these have thrown light on the effect of food on milk secretion, although a large proportion have had other objects in view. Experiments extending over six years have been made at the Wisconsin Station to compare the effects of corn silage and field-cured corn fodder on milk and butter production. The results of these have not been altogether consistent. In the earlier experiments (*R. 1888, p. 28*) the indications were that the silage tended to slightly increase the yield, giving a more watery milk. The later experiments (*R. 1889, p. 130, R. 1890, p. 80*); however, which form the majority, indicate that slightly more milk and of equally good quality was produced on silage.

At the Massachusetts State Station, in a long series of comparisons of corn fodder, corn stover, and corn silage, these materials were found to compare well, pound for pound, in their effect on yield and composition of milk.

At the Michigan Station the yield of milk was found to be slightly larger on silage than on corn fodder.

At the Maine Station, when corn silage and timothy hay (mostly timothy) were compared, the yield of milk was of equal or better quality on silage than on hay.

At the Vermont Station (*R. 1890, p. 86*) the milk yield was larger on hay than on silage or corn fodder; the quality of the milk was maintained on silage, but fell off slightly on corn fodder.

At the Massachusetts State Station (*R. 1889, p. 12*), in four years of comparison of corn fodder, corn stover, corn silage, sugar beets, carrots and hay, the effect of these different foods on the milk was not uniform with different cows, but seemed to be largely a matter of individuality. Both sugar beets and carrots when fed in place of part of the hay of a ration "almost without exception raised the temporary yield of milk, as a rule exceeding the corn silage in that direction."

The summary in *Vt. R. 1890, p. 73*, of a large number of cases where cows were changed from succulent to dry food and *vice versa*, showed practically no change in the composition of the milk which could be attributed to the change of food. The same station found (*R. 1890, p. 107*) that the change from barn feed to pasturage was almost universally accompanied by a greater or less increase in both the yield and the richness of the milk. According to observations reported in 1891 (*Vt. R. 1891, p. 69*) the increase on pasturage averaged about one-fourth of a pound of butter per week per cow. These results, together with other observations at the station in the same line, lead to the statement that "pasture feeding and watery food do not make watery milk."

At the Wisconsin Station (*R. 1889, p. 146, R. 1890, p. 164*), on the contrary, "an increase in the amount of water drank was associated with an increase in the amount of milk produced;" and "the water in the milk was greatest following the days when the most water was drank."

The New Jersey Station (*B. 77*) found in connection with its tests of dairy breeds that while the yield of milk generally increased during the summer months the quality fell off.

With reference to the effect of grain feed, a comparison at the Wisconsin Station (*R. 1885, p. 97*) of old-process linseed meal and corn meal gave indications that the linseed meal slightly improved the quality of the milk, but usually at the expense of quantity. Pound for pound, linseed meal gave slightly larger yield of milk than bran, with no apparent change of quality due to food (*Wis. R. 1886, p. 130*). In a comparison of equal weights of ground oats and bran, the cows invariably increased in milk yield on oats, with practically no change in the fat content of the milk (*Wis. R. 1890, p. 65*).

The Maine Station (*R. 1885-'86, p. 65, R. 1886-'87, p. 84*) found from trials in two years that "the substitution of cotton-seed meal for an equal quantity of corn meal unmistakably increased the production of milk and butter to a profitable extent."

At the Pennsylvania Station (*B. 17*) the substitution of cotton-seed meal for bran was accompanied by an increase of about one-fifth in the yield of milk, with practically no change in percentage of fat in the milk.

The New York State Station (*R. 1891, p. 112*) substituted cotton-seed meal for corn meal and silage for part of the hay in the ration of seven cows well advanced in milk. The change in the ration was an increase in both albuminoids and fat in the food. Not only was the milk yield maintained for a month on this richer ration at a time when the cows might be expected to be drying up, but in the majority of cases the percentage of fat increased, so that in every case except two there was an absolute increase in the quantity of fat secreted on the richer ration.

The Vermont Station (*R. 1890, p. 75*) studied the effect on milk of feeding a large amount of a rich grain ration as compared with feeding a normal amount. The effect was not uniform with the different cows. One gave no return for the extra grain either in yield or in richness of milk, while two others responded to the extra grain by increased yield of milk, the quality of which was not diminished.

The New York State Station (*B. 106, B. 110, B. 114, R. 1884, p. 49*) found that acid food, as spoiled or sour brewers' grains, wet starch feed, or dry starch feed to which acetic acid had been added, did not impart any unpleasant taste to milk or affect its keeping quality. The indications from a trial of feeding dry starch or glucose waste was that it tended to increase the yield of milk without affecting its composition (*N. Y. State R. 1885, p. 10*).

The same station (*B. 22, B. 34, B. 35*) found gluten meal very favorable to milk yield.

The New Hampshire Station (*B. 14*) noticed in a comparison of gluten meal and corn meal that "in almost every case with each of the eleven cows a change from gluten meal to corn meal, *i. e.*, a change from a narrow to a wide nutritive ratio, resulted in a decided falling off in the product (milk) while the reverse change resulted in an equally decided increase."

Probably the most interesting experiment of all on this subject was made at the Iowa Station (*B. 14*) in a comparison of gluten meal with corn-and-cob meal. When gluten meal, containing large amounts of protein and fat, was fed there was an increase both in the percentage of total solids and fat and in the total amount of fat produced in the case of every cow. The proportion of fat to the other milk constituents was noticeably larger on gluten meal. This would seem to be a case of a one-sided increase of the fat, which, as mentioned above, has been noticed in only a few isolated cases. The effect of the gluten meal on the yield of milk was not uniform, but apparently there was little if any change in yield which could be attributed to the food.

It will be seen that the results of carefully made experiments are often conflicting, which suggests that the element of individuality plays an important part in such experiments as these and makes it difficult to lay down fixed laws. The whole matter of the effect of food on milk and butter production is only imperfectly understood and needs more extended and consistent investigation.

From the results cited above it seems safe to assume for the present that in general corn fodder, corn stover, corn silage, and probably the root crops do not unfavorably affect either the yield or composition of milk; that succulent foods do not necessarily produce watery milk; and that such rich nitrogenous foods as linseed meal, gluten meal, etc., are especially favorable to milk production. The extent to which these foods can be given will naturally depend upon circumstances, such as the character of the stock, and the market value of these feeding stuffs and of dairy products.

(*Iowa B. 13; Kans. R. 1888, p. 91; Mass. State B. 32, B. 34, B. 35, B. 38, B. 41, R. 1884, pp. 26, 59, R. 1885, p. 10, R. 1886, p. 11, R. 1887, pp. 11, 35, R. 1888, pp. 11, 38, R. 1889, pp. 12, 48, R. 1890, p. 15, R. 1891, p. 59; Minn. R. 1888, p. 112; Miss. B. 13, B. 15; N. H. B. 13; N. J. B. 19; N. Y. State B. 84, R. 1883, pp. 95, 156, R. 1887, p. 15, R. 1888, p. 297, R. 1890, pp. 8, 364; Vt. R. 1889, p. 51, R. 1890, pp. 51, 88, 107; Wis. R. 1884, p. 11, R. 1885, p. 9, R. 1886, pp. 25, 34, 147, R. 1888, pp. 5, 67, R. 1889, pp. 69, 130, R. 1890, p. 80.*)

Milk fermentations.—The subject of milk fermentations in their relations to dairying has been treated in *B. 9* of the Office of Experiment Stations, U. S. Department of Agriculture.

Milk is subject to a very large number of fermentative changes which affect it in widely different ways. The most familiar forms are the ordinary souring of milk and the curdling of milk by rennet. The former is due to minute organisms (bacteria) which get into the milk after it is drawn, and the latter to the action of a ferment prepared from a calf's stomach. Besides these fermentations there are numerous others, as alkaline fermentations, butyric acid fermentation, alcoholic fermentations, fermentations which result in bitter milk or slimy milk, and others which result in blue, violet, red, yellow, and green milk.

The organisms and substances concerned in these fermentations of milk may be divided into two distinct classes, namely, organized and unorganized ferments. The former include the minute living organisms (microörganisms), such as bacteria, yeasts, etc., which by their growth cause changes or fermentation.

The unorganized or chemical ferments, on the other hand, are substances devoid of life which are capable of causing certain chemical changes in other substances without themselves being changed. Rennet and pepsin are familiar examples of unorganized ferments.

Bacteria proper, which have most to do with milk and cream, are found in immense numbers everywhere, and play an important part in nature. They are all extremely minute. In shape they show three chief varieties, which may be compared, respectively, to a lead pencil (*bacillus*), a ball (*coccus*), and a corkscrew (*spirillum*). With the highest powers of the microscope they appear as scarcely more than simple dots and lines. They are to be classed with plants rather than animals, in spite of the fact that many of them are endowed with motion.

The isolation and cultivation of a single kind of bacteria is a matter requiring the greatest care. Cultures containing only a single kind of bacteria are called pure cultures. Although imperfectly studied as yet, many different forms of bacteria are known which are distinguished by their habits of growth, the substances in which they thrive, and the changes which they produce in various substances as a result of their growth.

Yeasts are also plants of a low order which grow very rapidly in certain substances and thus cause changes which are commonly called fermentations. The most common kind of yeast is that used in making beer and raising bread.

It is becoming more and more evident every year that the bearing of these fermentations upon dairying is of the utmost importance. The practical application of our

knowledge of the fermentations of milk will concern each of the three chief dairy products, milk, butter, and cheese.

HANDLING MILK.—To those dealing with milk itself in any form the various fermentations are especially undesirable and are constant sources of trouble. Such persons want the milk pure and sweet, and any of the various forms of fermentation injure the milk for their purposes. Now, so far as these matters are concerned, the study of milk fermentations has taught us first of all that all fermentations of milk, even the common souring, are due to the contamination of the milk with something from the exterior after it is drawn from the cow. If they are thus all due to contamination from without, all that is needed to prevent them is to treat the milk in such a way that no such contamination is permitted. But simple as this is in theory, study has shown that it is a matter of practical impossibility. The various organisms affecting milk are so numerous and so common everywhere that no practical method can be devised for keeping them out of the milk. The person who handles milk must therefore recognize their presence in the milk as inevitable, and he must simply turn his attention to means of reducing them to the smallest number and keeping their growth within the smallest possible compass. This has been shown to be best accomplished by the two precautions, absolute cleanliness and low temperatures. The great source of these organisms is in the unclean vessels in which the milk is drawn and in the filth which surrounds the cow. By scrupulous cleanliness in the barn and dairy the number of organisms which get into the milk may be kept comparatively small. Of equal value in preserving milk is the use of low temperature, and to be of the most use it should be applied *immediately* after the milk is drawn. When drawn from the cow milk is at a high temperature, and indeed at just the temperature at which most bacteria will grow the most rapidly. If the milk is cooled to a low temperature immediately after it is drawn the bacteria growth is checked at once and will not begin again with much rapidity until the milk has become warmed once more. This warming will take place slowly, and therefore the cooled milk will remain sweet many hours longer than that which is not cooled. (This is the principle of the milk cooler.) Early cooling to as low a temperature as is practicable is the best remedy for too rapid souring of milk. A practical knowledge of this fact will be of great value to every person handling milk.

While the lactic organisms are so common and so abundant as to make it hopeless to try to keep them out of the milk, this is not true of the organisms producing the abnormal fermentations, such as blue milk, red milk, slimy milk, etc. These organisms are not so abundant, and by the exercise of care they may all be prevented from getting into the milk and causing trouble. If a dairy is suddenly troubled with slimy milk or any other abnormal trouble, the dairyman may feel sure that the cause is to be found in some unusual contamination of his milk and that the remedy must be extra cleanliness. He may, perhaps, find the cause in the hay, brewers' grains, or something of that sort which the milker has handled, or in the dust which has been stirred up in the milking shed. He must look for the trouble in something apart from the cow, and usually in his own carelessness, either in the barn or the dairy. We must always remember that with a healthy cow all contamination of the milk must come from the outside. Sometimes such troubles may be traced to an individual cow among a large herd. Such a cow should be cleaned, and especial care should be taken to carefully wash her teats with a weak solution of acetic acid for the purpose of removing whatever bacteria may be clinging to them. Such methods will soon remove the trouble.

It is well to notice that certain abnormal odors and tastes in milk may be produced directly by the food eaten by the cow. If a cow eats garlic or turnip the flavor of the milk is directly affected. Various other foods may in a similar manner affect the taste of milk, but this class of taints may be readily distinguished from those due to bacteria growth. The odors and taints due to the direct influence of the food are at their maximum as soon as the milk is drawn, never increasing after-

ward. But the taints due to bacteria growth do not appear at all in the fresh milk, beginning to be noticeable only after the bacteria have had a chance to grow.

Various methods have been devised for destroying the organisms after they have found their way into the milk. Numerous chemicals have been used, and several methods of using heat have been devised. Milk is preserved for family use or for infants by heating in bottles set in a vessel of water at about 165° for a half hour. The bottles are then closed with rubber stoppers or plugs of cotton, quickly cooled, and kept in a cool place. Into the details of this subject we can not go at present. The methods have been devised for the consumer of the milk rather than for the dairyman, and the latter need not concern himself with them. The lessons for the dairyman to learn from the study of the fermentations of milk are scrupulous cleanliness in all affairs relating to milk care in the dairy, thorough washing with boiling water of all milk vessels, and low temperatures applied to the milk immediately after it is drawn from the cow.

Butter making, ripening of cream.—To the butter-maker the bacteria of milk prove friends instead of enemies. After the cream is separated from the milk it proves of advantage to the butter-maker to allow bacteria to grow in it before churning. It is the custom of butter-makers to allow their cream to "sour" or "ripen" for a number of hours before churning. This is accomplished by allowing it to stand in a warm place for twenty-four hours. During this time the bacteria in it are multiplying rapidly and of course producing the first stages of the various forms of fermentation of which they are the cause. Prominent among them will be some of the lactic acid organisms, and these will produce the souring of the cream. But the changes which occur are not confined to the lactic acid organisms, for the warm temperature will hasten the growth of various other organisms which happen to be present in the cream. The butter-maker finds certain advantages in ripening, such as increased yield of butter in churning and improved flavor and aroma of the butter (see *Butter from sweet and from sour cream*).

The aroma of butter is undoubtedly connected with the decomposition products of the bacteria growth. The first person to investigate this matter, in the light of modern discoveries, was Storch, a Swedish scientist. He assumed that the butter aroma was due to the growth of organisms, and made a study of the bacteria in butter and cream for the purpose of finding, if possible, the proper species of organism for producing the aroma. After considerable search he finally succeeded in isolating from ripening cream a single bacillus which seemed to produce the proper butter aroma when it was used in pure culture to ripen cream. Shortly after this Weigmann studied the same phenomenon and also succeeded in obtaining cultures of an organism which produced a normal ripening and gave rise to a proper aroma. This ferment is coming into use in some of the creameries in Germany and Denmark, the claim being made for it that it insures certainty in the result of the ripening process. It has not yet been introduced into this country for practical purposes.

The value of using such a ferment, if it can be supplied in a practical manner, is easily seen. It will introduce improvements into the creameries similar to those introduced into breweries by means of the study of yeasts. In normal butter-making as practiced to-day there is no way of obtaining any control of the bacteria present in the cream. A given specimen of cream will contain a large variety of bacteria. Conn has shown (*Conn. Storrs R. 1890, p. 136*) that there may be a score of different species of bacteria growing in cream which has been collected in the usual way. The butter-maker has no means of regulating this assortment or even of knowing anything about it. During the ripening process there will ensue a conflict of the different organisms with each other, and the result will be influenced by temperature, variety of species, quality of cream, and length of time of ripening, as well as by the advantage which certain species of organisms may get from an earlier start. In such a conflict it will be a matter of accident if the proper species succeeds in growing rapidly enough to produce its own effect on the cream unhindered by the

others. Now it certainly makes a great difference in the product what species of bacteria happen to grow most rapidly. Storch found only a single species that produced the proper aroma, and Conn has found (*Conn. Storrs R. 1890, p. 158*) that cream ripened with improper species of bacteria produces very poor butter.

The bacteria which grow in ripening cream have been found to produce all sorts of disagreeable flavors and tastes in milk or cream if allowed to act unhindered. It seems to be only the first products that have the pleasant flavor. Too long a ripening results in the production of a butter containing too strong flavors, and one of the difficulties of butter-makers is to determine the right length of time for proper ripening.

The matter of the production of the proper butter aroma as the result of the use of artificial ferments in ripening cream is at present too uncertain for definite conclusions. We may be confident that the flavor of the butter is largely dependent upon the decomposition products of the bacteria that grow in the cream, and we have positive evidence that some organisms will produce much better quality of butter than others. We may hope that the further study of the decomposition products of different organisms and their relation to cream and butter will offer to the butter-maker the solution of this difficult problem in the future. If that occurs we may hope, not that the butter-maker will be able to make better butter than the best that is made to-day, but that he will be able to obtain the best product with uniformity; and we may also expect that the creameries which at present make an inferior quality of butter will be able to improve it so as to compete with the best.

As for the other purposes of ripening, it is not possible to say much at present. Evidently the greater ease of churning and the larger product obtained from ripened cream are matters closely related to each other. The simple fact is that fat is more easily collected into masses of sufficient size to be removed mechanically from the butter-milk; but why the ripening makes them thus more easily collected is yet not fully explained. The difficulty of an explanation lies in the fact that we do not know exactly the condition of the fat in the milk.

CHEESE-MAKING.—The ripening of cheese has been proved to be a matter of the action of microörganisms. Bacteria are then an absolute necessity to the cheese-maker, for as a result of their slow, long-continued action, cheese acquires a rich, delicate flavor and other desirable characteristics, without which it is unpalatable and worthless. The ripening process has been shown to consist chiefly in the transformation of insoluble casein into soluble albuminoids, and it appears that it is associated with the production of several ferments. The number of organisms in ripening cheese has been found to be from 25 to 165 millions per ounce and to increase slowly during ripening. These include a large number of different kinds of bacteria, but proper ripening is believed to be due to a limited number of different species, perhaps a single species. Abnormal ripening, resulting in black cheese, bitter cheese, cheese flecked with red spots, poisonous cheese, and several other troublesome infections, have all with certainty been traced to the action of bacteria, and will be avoided when we learn to ripen cheese with pure cultures of the proper species of bacteria. As yet we have only learned that there is a causal connection between the ripening and the microörganisms; but the conditions affecting their growth, the variety of species which can produce a normal ripening of cheese, whether different species of organisms will produce differently flavored cheeses, whether the cheeses of the markets are due to different organisms used in the ripening or chiefly to different conditions under which they are grown, are all problems to be settled before any practical results can be expected.

We may then, perhaps, predict a time in the not distant future when both the butter-maker and cheese-maker will make use of fresh milk. The butter-maker will separate the cream by the centrifugal machine in as fresh a condition as possible and will add to the cream an artificial ferment consisting of a pure culture of the proper bacteria, and then ripen his cream in the normal manner. The result will be uniformity. The cheese-maker will in like manner inoculate fresh milk with an

artificial ferment, and thus be able to control his product. Perhaps he will have a large variety of such ferments, each of which will produce for him a definite quality of cheese. To the dairy interest, therefore, the bacteriologist holds out the hope of uniformity. The time will come when the butter-maker may always make good butter and the cheese-maker will be able in all cases to obtain exactly the kind of ripening that he desires. (*Conn. Storrs B. 4, R. 1890, p. 136, R. 1891, p. 172.*)

Milk fever in cows [also called Parturient apoplexy].—A brain affection, due in many cases to breed peculiarities, over feeding, or lack of exercise before calving. Among exciting causes after calving are sudden changes in the weather, cold drink, or improper food. One attack predisposes to another. It appears from one to three days after calving. The symptoms are a slight chill, diminished secretion of milk, loss of appetite, hard and loud breathing, blood-shot eyes, hot ears, horns, and forehead, cold extremities. At first there is slight fever, but the temperature soon falls below the normal. The bowels are constipated, with retention of urine. The animal finally drops and struggles violently for a time. The symptoms run their course in from two to twenty-four hours.

For treatment the animal should be kept in comfortable quarters and as far as practicable in a natural recumbent position. The Indiana Station (*B. 17*) advises giving 20 to 30 ounces of whisky or brandy diluted in warm water. After half an hour administer from one to two pints of molasses dissolved in hot water; repeat this treatment every four to six hours. Apply ice or cold water to the head. The Rhode Island Station (*B. 6*) advises the use of a "wet pack," made by covering the animal with a wet sheet over which blankets are put, to cause and keep up perspiration. Laxative medicine should be given. If paralysis of the throat occurs hypodermic injections of eserine are useful.

This disease may be prevented by careful feeding and keeping the bowels active previous to calving.

(See also *La. B. 10, 2d ser.; Me. R. 1889, p. 262.*)

Milk tests.—One of the most useful things which the stations have done for dairying has been to call attention to the vast difference in the quality of milk given by different cows, and to place in the hands of the dairymen several simple and approximately accurate methods for testing the quality of the milk given by each cow in his herd. Through the efforts of the stations farmers and breeders are coming to understand that the value of a cow for butter making is not shown by the quantity of milk, but by the amount of butter-fat she gives; and that cows which ordinarily pass for good cows may differ greatly in the amount of butter-fat which they yield. They know, too, that it costs nearly or quite as much to keep a poor cow as a good one, which means that the cost of food per pound of butter will be very much higher in the case of the poor cow than in that of the good one. Nearly every farmer who has roughly studied his cows by the yield of the churn realizes that while some are profitable, many are really kept at a loss, and these latter naturally eat up part of the profits from the better animals. To weed out the less profitable or unprofitable animals from a herd, and to make sure that every animal kept is qualified in a high and profitable degree to convert the hay and fodder articles of the farm into butter-fat, is an important matter, and one upon which success in dairying largely depends. And this is one of the provinces of the simple milk tests.

The churn test, which until recently has been the farmers' main dependence, requires too much time and labor to be commonly and rigidly applied. The ordinary methods of the chemical laboratory require too complex and costly apparatus and too skillful manipulation to be adapted to the use of farmers or creameries.

Simple methods depending on the specific gravity (lactometer) or on the thickness of the cream layer in cream tubes, do not furnish satisfactory indication of the actual amount of fat. All methods depending upon the color or transparency of the milk are likewise unreliable. The transparency of milk is affected by the size

of the fat globules, so that samples of milk containing like percentages of fat may be unequally transparent.

The lactocrite, an apparatus by which the fat of a given quantity of milk, after having been set free by a mixture of sulphuric and acetic acids, is separated and collected by centrifugal force, is an expensive piece of apparatus and the method has not made its way into general use.

The "oil test," which is practically a churn test on a small scale, has been found (*Wis. B. 12*) by actual comparison with a large churn to differ, with the same cream, by 3 or 4 per cent of butter-fat, not all the materials separated by the method being actually fat.

Numerous other methods, which from time to time have been proposed, have not seemed to answer the demand, or at least have not found general application, because they were either too complicated, expensive, or insufficiently accurate.

No less than seven different methods, all quick and fairly reliable, but differing somewhat as to simplicity of apparatus and manipulation, have been devised and subjected to very rigid trials at the stations, both by experienced chemists and by farmers, dairymen, and others unaccustomed to chemical work. These simple methods all depend upon the same general principle. The casein, albumen, fibrin, etc. ("curd"), of the milk surround the minute fat globules and hinder their rising as cream and aggregating to make butter. By treating the milk with acids or alkali this curd is more or less acted upon or dissolved, thus diminishing the hinderance to the rising of the fat globules. These collect at the top of the solution in a layer, the thickness of which can be readily measured. This separation of the fat from the dissolved curd is aided by either collecting the fat in gasoline or ether, which is afterwards evaporated, or by adding hot water, or by centrifugal motion.

Short method (*Wis. R. 1888, p. 124*).—This was the first of these quick methods to make its appearance, and is the only one in which the nature of the fat is changed. It depends upon the fact that when milk and a solution of strong alkali (caustic potash and soda) are heated together at the temperature of boiling water for a sufficient time the alkali and the fat of the milk unite to form a soap, as occurs in ordinary soap manufacture where fats and grease are heated with alkali (potash or soda). This soap is dissolved in the hot liquid. The casein and albumen are changed by the alkali and become much more easily soluble. If an acid is now added (a mixture of acetic and sulphuric acids is used in this method) the alkali of the soap is taken away by the acid, leaving the fat free. The casein, albumen, etc., are first precipitated and then dissolved by the acid. There is then nothing left in the milk to prevent the fat from following the law of gravity and rising and collecting in a narrow tube at the top of the liquid, where it may be measured by a graduated scale like that of a thermometer. The percentage of fat indicated by this reading is found by reference to a table. The author states that this method does not give accurate results where less than 0.5 per cent of fat is present, unfitting it for testing skim and buttermilk low in fat. In 146 comparisons, made by different stations, of this method and the gravimetric methods ordinarily used by chemists, twenty-one showed differences of 0.2 per cent or more from the gravimetric, this difference being very rarely more than 0.3 per cent. Of six samples of skim-milk tested four differed by 0.2 to 0.22 per cent. The time required for a single analysis is approximately three and a half hours, although several analyses may be made at the same time.

Parsons method (*N. H. R. 1888, p. 69; N. Y. State B. 19, n. ser.*).—The measured milk, according to this method, is shaken with alkali (soda solution), alcoholic soap solution, and gasoline. The gasoline under these conditions dissolves the fat and rises with it to the surface. A part of this solution of fat in gasoline is measured out, the gasoline evaporated, a few drops of strong acetic acid added, the fat dried in an oven, and what remains behind measured in a narrow graduated tube. From this measurement the percentage of fat in the milk is found by reference to a table. The time required for the analysis is about two and a half hours, but

several analyses may be made at the same time. Of ninety-three trials made with whole milk six differed from the gravimetric determination by 0.2 per cent or over; of seventeen tests of cream five differed by 0.2 per cent or over, the greatest error being 0.52 per cent; and of thirteen tests of skim milk there was in no case as large as 0.15 per cent. The cost of the necessary apparatus is from $5 to $10, depending upon the number of duplicates to be made at once.

Failyer and Willard method (Kans. R. 1888, p. 149).—The casein, albumen, etc., are dissolved by heating the milk with strong hydrochloric acid, the fat is dissolved and collected at the surface by gasoline, and the gasoline is evaporated by gentle heat, leaving the fat free. Hot water is now added, which brings the fat up into the narrow graduated neck of the tube where it can be read off.

The time required is about half an hour for a single sample, or an hour and a quarter for four samples. In five out of twenty-two trials made there was a difference of 0.2 per cent or over from the gravimetric analyses.

Patrick method; Iowa Station milk test (Iowa B. 8, B. 9, B. 11).—The curd (albumen, casein, etc.) of the milk is dissolved by boiling the milk with a mixture of sulphuric and hydrochloric acids and sulphate of soda, the last being used to prevent the formation of a scum of undissolved materials which holds the fat. The acid mixture, as recently modified, contains rectified methyl alcohol. The liquid is then cooled, the fat rises to the surface, is heated again to clarify it, a part of the acid solution is drawn off through a small hole in the body of the tube ordinarily closed by a rubber ring, and the column of fat is read off on the scale. The time required is about twenty minutes for a single test or six may be made in one and a half hours. The cost of chemicals is not more than one cent for each analysis. In thirty-five trials of this method the results of only three differed by 0.2 per cent from the results obtained by the gravimetric (laboratory) method; and in thirteen tests of skim milk only one test differed by 0.2. The method has not given good success with samples of buttermilk.

Cochran method (Journal Analytical Chemistry, vol. III, p. 381; N. Y. Cornell B. 17; Pa. B. 12).—The chemicals used in this method to dissolve the casein, etc., are sulphuric and acetic acids, which are heated with the milk about six minutes. After cooling, ether is added which dissolves out the fat and brings it to the surface. The ether is evaporated by gentle heat, and the liquid poured into a narrow measuring tube, where, after the addition of hot water, the fat collects in a clear layer and is read off. A table gives the per cent of fat corresponding to the reading of the tube.

In ten trials out of fifty-nine made by this method the results differed by 0.2 per cent of fat or over from the results by chemical analysis. In nine analyses of skim milk this difference was in only one case as high as 0.15 per cent; in six tests of buttermilk the greatest difference was 0.27, all others being under 0.15 per cent.

The method is covered by a patent. It is not a station method, but has been tested by several stations. The cost of apparatus and the right to use the method varies from $10 for the dairyman's outfit, sufficient for testing four samples at a time, to $50 for the large creamery outfit for making sixty tests at one time. The cost of chemicals is about one-half cent per analysis, and the time required one-half hour for a single test, or one and a half hours for twenty-four tests.

Beimling or Vermont Station method (Vt. B. 21).—This test, which is similar to the one devised by Dr. Babcock, depends on dissolving the curd by treating the milk with a mixture of hydrochloric acid, without the application of heat, and whirling the bottles containing the liquid in an improved centrifuge for from one-half to one minute. This is said to be sufficient to cause the fat to collect in the narrow neck of the bottle where it is read off, the reading indicating the per cent of fat in the milk taken. No hot water jacket around the separator or hot water in the bottles is used. The time required for a single test is not more than five minutes, and twenty-five samples can be tested in an hour.

In the case of twenty-four samples which were tested by an inexperienced person, 75 per cent of the results were within 0.1 of the chemical analyses, and in no case was the error as large as 0.3 per cent. Prof. Cooke says, "If the sample has been correctly taken and the column of fat in the tube is correctly read, there is no chance for the results to be wrong." Skim milk and buttermilk containing less than 1 per cent of fat can not be accurately tested by this method. The cost of chemicals is not more than one-fifth cent per test. The machine is patented and costs, including bottles, from $20 to $50, according to the size, the one suggested for creameries carrying six bottles and costing $25.

Babcock method (*Wis. B. 24, 31*).—In this method the curd is dissolved by sulphuric acid, no heat being applied. The separation of the fat is then aided by a simple centrifugal apparatus consisting of a wheel fitted with pockets and surrounded by a tank filled with hot water (about 200° F). The bottles containing the liquid are placed in an inclined position within the pockets of the wheel with the mouths toward the axis and whirled rapidly for several minutes. The acid and the dissolved curd and water of the milk being much heavier than the fat are thrown outward (to the bottom of the bottle) by the rapid motion and the fat collects near the neck. The separation of the fat is rapid and very complete. Hot water is now added to bring the fat up into the graduated neck, and the bottles are whirled for a few minutes more to clarify it. The reading of the column of fat gives the per cent directly.

"Two samples of milk may be tested in duplicate in fifteen minutes, including all the work from the mixing of samples to the cleaning of bottles. After the milk has been measured sixty tests may be made in less than two hours, including the cleaning of the bottles." The cost of the acid for the test should not exceed one-half cent per test. With properly made bottles the breakage is very slight. This test has been adapted to testing cream. (*Conn. State B. 106, B. 108, R. 1891, p. 107*; *Me. B. 3.*)

The Babcock method has been more thoroughly tested and has found wider application than any of the others. Hundreds of comparisons of this method and the gravimetric method are on record, the overwhelming majority of which go to show that the Babcock test properly manipulated gives accurate results, and that it is practical. It has been practically applied in thousands of private dairies and cheese and butter factories throughout the United States, and is used at the stations, the agricultural colleges, by dairy commissions, city milk tests, etc. Its use marks one of the most important advances in dairying in this country.

(*Colo. B. 20; Conn. State B. 106, B. 108, R. 1891, p. 107; Del. R. 1889, p. 164; Ill. B. 10, B. 9, B. 12, B. 14, B. 16, B. 18; Iowa B. 8, B. 9, B. 11, B. 13; Me. B. 3, 2d ser.; Miss. B. 15, R. 1891, p. 28; N. Y. Cornell. B. 25, B. 29; Nev. B. 16; Pa. B. 12, R. 1890, p. 172; Vt. B. 16, R. 1888, p. 144; W. Va. B. 13, R. 1890, p. 77; Wis. R. 1890, p. 98.*

Milking.—The advantages of thorough milking have been brought out by trials at the Mississippi Station (*Miss. R. 1888, p. 42*).

The Wisconsin Station (*R. 1889, p. 44*) reported experiments on the effect of change of milker, rapidity of milking, manner of milking, milking tubes *vs.* hand milking, and milking one teat at a time. Differences were noticed between good milkers which were attributed to the manner of milking, since the cows were all milked dry. The greatest effect was always noticed at the first milking after a change of milker, and with some cows this was more marked than with others.

In the comparison of milking fast and slow, cows were milked in from three to four minutes, and in double that time. The yield of milk seemed to be little affected, but in every case richer milk was given when the cows were milked fast, and this was most marked with cows giving the most milk. On an average from the whole lot of cows there was a gain of 11.73 per cent in the total yield of fat from fast milking. This difference in quality, however, seemed to decrease gradually, though not to disappear altogether. When cows were milked one teat at a time there was a decided difference in the composition of milk from the different teats. The milk

richest in fat was invariably obtained from the teat milked second, that milked first coming next in richness, that milked third following, and that milked fourth the poorest. If the order in which the teats were milked was changed, the order of richness also changed so as to conform to the above rule, indicating that the richness of the milk from separate teats was due to the order of milking rather than to any characteristic differences in the parts of the udder. With this manner of milking the average percentage of fat in the milk from all four teats was considerably below that with ordinary milking. Comparisons of milking by hand and with tubes were, as a rule, unfavorable to the milking tubes. On the whole, the yield was slightly less with tubes than with hand milking, and the quality of the milk was poorer, although there were individual exceptions to this rule. The average for the eight cows tested showed a total loss with tubes of 6.5 pounds of milk and 2.718 pounds of fat per day.

As to the frequency of milking, tests made at the New Hampshire station of milking hourly and at the Vermont Station of milking two and three times a day, indicated that while there was a gain in some cases from frequent milking this was only temporary and was not apparent after two or three days. There was often a decrease in both yield and composition when frequent milking was continued. The Vermont Station found that in these fluctuations of quality the fat only was affected, the casein, sugar, and ash remaining practically constant. (*N. H. B. 9; Vt. R. 1890, p. 90.*)

Milking tubes.—See *Milking.*

Millet.—Under this general name are included a number of different kinds of grass. The popular names given to the various species are so numerous and so confused that great care is necessary in distinguishing them.

Common millet (*Panicum miliaceum*) is an annual grass, from 2 to 4 feet high, with profuse foliage and abundant flowers in open nodding panicles, grown in the United States chiefly for green fodder, (*Tenn. B. vol. V, 2*).

Texas millet (*Panicum texanum*) is an annual grass, from 2 to 4 feet high, with an abundance of rather short and broad leaves. It is a native of Texas, where it is grown for forage and hay. "On rich, moist soil it yields several cuttings during the summer, and a total of 3 or 4 tons of hay per acre." Dr. Collier's analysis of Texas millet gave the following results: Albuminoids, 4.70; fiber, 23.16; nitrogen-free extract, 47.07; fat, 2.12 per cent. (See also *O. E. S. B. 11; N. C. B. 73.*)

Pearl millet (*Pennisetum spicatum*) [also called Egyptian or Cat-tail millet] is an annual grass, from 3 to 6 feet high, with long broad leaves and a stout stem, terminated with a thick, erect "head" (panicle), 6 to 10 inches long, resembling the spike of the common cat-tail. It is cultivated for green forage chiefly in the Southern and Southwestern States. It is commonly sown in drills 2 and 3 feet apart, and is cultivated like corn. It prefers rich and moist soil. After flowering the stem grows woody. In an experiment at the Georgia Station, pearl millet yielded 19.474 pounds of dry fodder per acre from three cuttings.

An analysis of the dry matter gave the following result:

	Protein.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per ct.*	*Per ct.*
First cutting	16.64	30.71	37.37	15.28
Second cutting	2.17	14.60	59.57	13.66
Third cutting	13.65	38.37	36.50	11.48

(*Ala. Canebrake B. 9; Ga. B. 12; Kans. R. 1889, p. 43; La. B. 8, 2d ser.; N. C. B. 73; O. E. S. B. 11; Tenn. B. vol. V, 2.*)

Italian or golden millet (*Setaria italica*) is an annual grass, 2 to 4 feet high, with numerous long and broad leaves and a terminal spike-like panicle 4 to 6 inches long. "The millets of this class are ready to cut just as heading out and before blooming. They make a valuable and safe forage, but in more advanced stages the feeder should be exceedingly careful, for when ripe these millets act injuriously upon the kidneys" (*Tenn. B. vol. V, 2*). The results of an analysis of golden millet at the North Carolina Station were as follows: Albuminoids, 6.4; fiber, 25.5; nitrogen-free extract, 45.70; fat, 1.7 per cent (*N. C. B. 73*).

German millet or Hungarian grass (*Setaria italica* var. *germanica*) differs from the Italian millet in having a more dense or compact panicle, which is usually erect. The following analysis is reported by the New Jersey Stations (*R. 1889, p. 176*): Dry matter, 92.23 per cent; fat, 0.87; protein, 3.95; carbohydrates, including fiber, 45.69; ash, 6.18; nitrogen, 1.21; phosphoric acid, 0.35; potash, 1.29 per cent. (See also *Appendix, Tables I and II.*)

Golden Wonder millet, a new variety of the same class as German millet, has bright yellow heads (*Iowa B. 7; Kans. R. 1889, p. 43; La. B. 8, 2d ser.*)

Japanese millets (*Setaria italica* vars.). Several varieties of millets grown at the Massachusetts Hatch Station from seed imported from Japan have yielded large crops of stalks and seed (*Mass. Hatch B. 7, B. 18, R. 1890, p. 4, R. 1891, p. 9*).

African or Indian millet (*Sorghum vulgare* or *Andropogon sorghum* var.), is a form of the botanical species to which belong sorghum, broom corn, durra, Kaffir corn, millo maize, and chicken corn. It grows 8 to 10 feet high, and has a large head 12 to 14 inches long. If cut and cured when the seeds are in the dough stage it keeps well in out-door shocks and is relished by stock. It is also excellent for green food. The grain may be safely fed to animals (*La. B. 8, 2d ser.*). It is adapted to the Southern and Southwestern States.

Many-flowered millet (*Milium multiflorum*), introduced into California from New Zealand in 1879, "makes a great abundance of excellent forage, which, when cut young, is fine and tender, and practically frost-proof." The seed is very small. This grass requires careful management to get a good stand, and for this reason has not proved generally satisfactory to California farmers who have tried it. On the experimental plats at the California Station it grows well (*Cal. R. 1885–'86, p. 91, R. 1890, p. 209*).

Millo maize (*Sorghum vulgare* or *Andropogon sorghum* var.).—A non-saccharine variety of sorghum similar to Kaffir corn (see p. 187) and durra (see p. 121). It has tall, slender, and juicy stalks with abundant foliage, and produces a considerable number of suckers. The heads are erect, in compact panicles, with large seeds. It requires a longer season of growth than Kaffir corn, and therefore in many localities is liable to injury by frost. Two varieties, white and yellow, are grown.

At the Kansas Station (*B. 18*) in 1889 millo maize yielded 15 tons of green fodder and 57 bushels of seed, but in 1880, an unfavorable season, it yielded only 5 tons of green fodder and 2 bushels of seed per acre. In 1888 it was killed by sorghum blight (*Kans. R. 1888, p. 64*).

At the Georgia Station (*B. 12, B. 17*) the white variety has yielded from 16 to 25 tons of green fodder and from 3½ to 7 tons of dry fodder at three cuttings, and the yellow variety from 14½ to 23 tons of green and from 3 to 7 tons of dry fodder at three cuttings. As compared with other forage crops grown at the same time these yields were relatively large.

At the Louisiana Station (*B. 8, n. ser.*) millo maize produced a large amount of green fodder, but required all summer to mature seed. At the North Louisiana Station in 1890 it yielded 11½ tons of dry fodder and 34 bushels of seed per acre.

The yellow variety gave a large yield on the black bottom land at the Alabama Canebrake Station (*B. 9*).

At the Texas Station (*B. 3*) millo maize grows well and resists drought, but is not considered superior to other sorghums for forage.

At the California Station it has proved of equal value with Kaffir corn (*Cal. R. 1890, p. 210*).

At the Colorado Station it yielded an abundance of fodder and seed with a small amount of irrigation, but is liable to injury by frost (*Colo. R. 1889, p. 125; R. 1890, pp. 20, 211*).

Minnesota Station, St. Anthony Park.—Organized under act of Congress in 1888 as a department of the University of Minnesota. The staff of the station consists of the president of the college, director, agriculturist, horticulturist, entomologist and botanist, chemist, dairyman, and secretary. The principal lines of work are chemistry, field experiments with vegetables and fruits, entomology, and dairying. Up to January 1, 1893, the station had published 2 biennial reports and 25 bulletins. Revenue in 1890, $22,746.

Mississippi Station, Agricultural College.—Organized under act of Congress February 1, 1888, as a department of Mississippi Agricultural and Mechanical College. The staff consists of the president of the college, director, assistant director, agriculturist, entomologist, assistant botanist, horticulturist, veterinarian, two chemists, treasurer, and superintendents of substations at Ocean Springs, Holly Springs, and Lake. The principal lines of work are botany; field experiments with field crops, vegetables, and fruits; feeding experiments; veterinary science and practice; entomology; and dairying. Up to January 1, 1893, the station had published 4 annual reports and 23 bulletins. Revenue in 1892, $15,000.

Missouri Station, Columbia.—Organized under act of Congress January 2, 1888, as a department of Missouri Agricultural College of the University of the State of Missouri. The staff consists of the president of the college, director and agriculturist, chemist, horticulturist and entomologist, veterinarian, assistant chemist, farm superintendent, secretary, and treasurer. The principal lines of work are chemistry; field experiments with field crops, vegetables and fruits; feeding experiments; and veterinary science and practice. Up to January 1, 1893, the station had published 1 annual report and 18 bulletins. Revenue in 1892, $19,057.

Molasses.—The sirup which drains from cooling sugar during the process of manufacture. At the Texas Station (*B. 10*) molasses was advantageously introduced into a ration of cotton-seed meal and cotton-seed hulls for cattle. The use of half a pint of molasses for each daily ration resulted in the profitable consumption of a larger amount of food by cattle. Molasses did not improve a ration consisting largely of silage. At the Maryland Station (*B. 8*) molasses was added to a ration of corn meal, cotton-seed meal, hay, and rye straw for fattening work oxen. (*Conn. State R. 1888, p. 106; Ky. R. 1888, p. 27; La. B. 11, 2d ser.; Miss. R. 1888, p, 45.*)

Mowing machines.—See *Dynamometer tests of farm implements.*

Muck.—See *Peat.*

Mulching.—A mulch is anything spread on the ground to hinder evaporation of water from the surface. It is a matter of common observation that straw, leaves, chips, sawdust, boards, stones, etc., lying on the soil, keep it moist. They allow the soil water to flow freely up to the surface, but there the movement is checked. Stirring the surface soil by impairing its capillarity accomplishes, in a measure, this same result, but not so effectively as mulching. From experiments at the New York State Station (*R. 1888, p. 186*), the conclusion is drawn that "a slight mulch exerts a far greater influence in retaining water than tillage 4 inches deep," and in experiments on corn at the Missouri Station (*B. 14*) mulching prevented evaporation as effectually as thorough tillage.

Mulching, moreover, preserves the tilth by preventing puddling, protects from surface washing when heavy rains occur, and prevents growth of weeds.

Its value as a winter protection to grass and other plants is well known, and it is a common opinion that a large part of the value of top-dressings with barnyard manure on grass is due to its action as a mulch.

Mulches, however, find their chief application as mitigators of drought. They conserve the moisture in dry seasons, and keep the soil cool. These facts are clearly brought out in experiments at the Missouri College (*B. 4*), with corn and potatoes on mulched and unmulched soil.

The use of mulches in reclaiming galled lands, and the comparative value of different kinds of mulches, have been the subject of quite an extensive report by the Tennessee Station (*B. vol. III, 4*).

In this report brief accounts are given of twenty-one experiments, from 1878 to 1890, inclusive, in reclaiming hillside land from which the soil had been washed, leaving exposed the clay and subsoil, scarred by deep gullies. Success was not attained until stable manure was liberally used, together with mulches.

Attention is called to the action of microbes in helping to make atmospheric nitrogen available to leguminous plants, and it is stated that these microbes multiply to an enormous extent in the decaying vegetable substances in mulches.

Statements on the value of clover haulm as a mulch are quoted from the report of the station for 1885–'86 (p. 135), and reference is made to experiments with damaged silage as a mulch on corn, recorded in the annual reports of the station for 1882–'86. Green weeds and straw from stubble fields are recommended as good materials for mulching.

"Sedge grass deserves special mention on account of cheapness, abundance in many sections, extent of land covered by a given amount—four loads per acre for grass or clover—and general efficiency. It is especially valuable and practicable for 'galled' hillsides or on thin land, where it is desirable to grow a crop of clover to turn under. It settles very close to the ground after the first rain, effectually prevents washing, and will not blow off after once becoming settled."

The following is a list of the materials used for mulch by the author of the above report, in the order in which he values them: Clover haulm, damaged silage, green weeds and straw from stubble field, sedge grass, briers, weeds, and trash from fence corners, partially rotten straw, straw, sorghum cane pomace, dry weeds and trash from clover fields in spring, and brush.

(*Mo. College B. 4; N. Y. State R. 1886, p. 163; Tenn. B. vol. III, 4, R. 1882, p. 122, R. 1883–'84, p. 78, R. 1885–'86, pp. 101, 135.*)

Mulberry (*Morus* spp.).—Varieties of the mulberry belonging to various species have been planted and observed at several stations. (*Cal. B. 8, R, 1888–'89, pp. 49, 87, 110, 138, 186, 197, R. 1890, p. 233; Mich. B. 55, B. 67, B. 80; Minn. R. 1888, p. 286; Mo. College B. 26; N. Y. Cornell B. 46; S. Dak. R. 1888, p. 28.*)

N. Y. Cornell B. 46 presents a full discussion of the merits of the mulberry, historical notes respecting its culture in this country, a description and classification of varieties and species, and some culture notes. It is held that the mulberry is a neglected tree. "It possesses decided value in ornamental planting, and some of the varieties are useful for hedges, shelter belts, and small timber. The fruit has merit for the dessert, is easily grown, and is produced more or less continuously throughout a period of two to four months every year." The value of the mulberry as a fruit-bearing tree is especially emphasized.

While the botany of the mulberry is recognized to be perplexing, there are three well-marked general types in cultivation—the white, black, and red (*M. alba, M. nigra*, and *M. rubra*)—besides the *Multicaulis* group, *M. latifolia*, and the Japanese group, *M. japonica*. The "New American" of the white group is considered to be the best mulberry yet known for the Northern States. The Downing from the *Multicaulis* has the greatest reputation, but the true Downing is now little known except in the South. The Russian subgroup of the white mulberry type has been largely introduced in the West, and is valuable for hedges and small timber on the prairies, and for ornamental planting. (In *S. Dak. R. 1888, p. 28,* it is said to be a failure as a tree, but good for hedges).

The native red mulberry is regarded as the parent of four varieties, of which one, the Hicks, is much used in parts of the South to supply food for swine.

M. rubra "has given us some of the most important varieties, and, as it is naturally variable and adapted to our various climates, it is the probable progenitor of the American mulberries of the future."

The California Station also looks upon the mulberry with high esteem. "The value of the mulberry for shade, for fruit, for home use, for timber, ultimately for silkworm culture, and its extreme ease of culture, make it desirable that the people should know more about the tree. It thrives on widely different kinds of soil, and at all the stations in that State. (*Cal. R. 1890, p. 233.*) All the types adopted in the New York Cornell bulletin are named as "best adapted to the greater part of California, including the interior, where they rival the fig in enduring heat, even where only a moderate supply of moisture is to be had. The best growers and the handsomest trees of the group have proved to be the Japanese *Nagasaki* and *Shoo,* which also have a large leaf of close texture, admirably adapted for the food of the silkworm."

At the Minnesota Station the Russian variety was on trial with doubtful success; this was found hardy at the Michigan Station, but, in general, mulberries were not regarded quite hardy in that State, even near the lake.

Muriate of potash.—See *Fertilizers* and *Potash.*

Muskmelon (*Cucumis melo*).—Tests of varieties sometimes including the cantaoupe are recorded as follows: *Colo. R. 1889, p. 101, R. 1890, p. 192; Ky. B. 32; Minn. R. 1888, p. 249; Nebr. B. 12; Nev. R. 1890, p. 16; N. Y. State R. 1882, p. 126, R. 1883, p. 185, R. 1884, p. 202, R. 1885, p. 121, R. 1886, p. 237, R. 1887, p. 321; Utah B. 3.*

Tests of varieties of cantaloupes are reported in *Ala. College B. 20, B. 28, n. ser.; Ala. Canebrake B. 2, B. 6; Ga. B. 14; Ky. B. 38; N. Y. State R. 1883, p. 185, R. 1884, p. 202, R. 1885, p. 121, R. 1886, p. 237, R. 1887, p. 321.*

Analyses of muskmelon varieties with reference to sugar content were made at the Massachusetts State Station (*R. 1889, p. 311, R. 1891, p. 336*), for which see *Appendix, Table III.*

A note in *Fla. B. 14* describes the manner in which muskmelons were successfully grown at that station. At the New York State Station (*R. 1884, p. 204*) the theory was tested that the earliness and productiveness of melons is promoted by pinching off the ends of the stems, thus encouraging the growth of the branches, upon which the first flower is invariably female. The advantage of the method proved to be only theoretical.

The roots of a plant were washed out at the New York State Station (*R. 1886, p. 161*), showing that the tap root at the depth of 4 inches became nearly horizontal, descending very gradually; and that the horizontal roots, one of which was traced to a distance of 5 feet, lay 2 or 3 inches below the surface.

Experiments in grafting muskmelons are noted under *Cucurbits.*

The accepted opinion that cucumbers spoil muskmelons when planted near was refuted by an experiment in which ninety-seven muskmelon flowers were pollinated from cucumbers of different varieties and no fruits at all were developed (*N. Y. Cornell B. 25*). Germination tests of muskmelon seed are recorded in *N. Y. State R. 1883, pp. 60, 69; Ohio R. 1885, p. 177; Ore. B. 2; Vt. R. 1889, p. 106.*

Mustard (*Brassica* spp.).—Five varieties of mustard were planted at the New York State Station (*B. 6, R. 1885, p. 192*). One of these—the tuberous-rooted mustard—is noted as a new introduction. "The roots, which form the part most used, are thick and fleshy, resembling in form, color, and taste those of the half long white radishes."

White mustard tested at the Pennsylvania Station (*R. 1888, p. 44*) as a forage crop yielded only about 1 ton per acre. For analysis with reference to food constituents, see *Appendix, Table III.* Germination tests of mustard seed are on record in *Ohio R. 1885, p. 167; Ore. B. 2; Vt. R. 1889. p. 106.*

Mycology.—See *Fungi* and *Diseases of plants.*

Nebraska Station, Lincoln.—Organized under act of Congress July 1, 1887, as a department of the University of Nebraska. The staff consists of the chancellor of the University, director and agriculturist, botanist, chemist, physicist, two assistant

chemists, entomologist, horticulturist, assistant agriculturist, assistant physicist, foreman of farm, and treasurer. The principal lines of work are chemistry, meteorology, soils, field experiments with field crops, vegetables, and fruits, and entomology. Up to January 1, 1893, the station had published 5 annual reports and 20 bulletins. Revenue in 1892, $15,176.

Nectarine (*Prunus persica* var.).—Variety tests of the nectarine are recorded as follows: *Ark. R, 1888, p. 57; Cal. R. 1882, p. 82, R. 1888–'89 pp. 86, 109, 137, 194; La. B. 8, 2d ser; Mo. B. 10; Nev. R. 1890, p. 30; N. Mex. B. 4; N. Y. State R. 1884, p. 22; R. I. B. 7; Tenn. B. vol. III, 5; R. 1888, p. 12; Va. B. 2.*

Nematode root galls (*Heterodera radicicola*).—Diseases of plants caused by the attacks of minute thread-like worms. Nearly all our economic plants are subject to the attacks of nematodes, but they are especially injurious to peas, beans, beets, melons, cucumbers, potatoes, tomatoes, cabbage, turnips, parsnips, celery, cotton, and young nursery stock. These pests attack the roots, causing variously shaped knots or galls to form. After the galls have reached their greatest size they begin to decay. Often the root wholly or partially rots off, and the plant wilts and dies, or at least becomes greatly stunted.

In new ground the nematodes cause but little damage. It is said that a very dry soil is not as favorable to their growth as a wet one.

They spend their entire life underground and are so small, hardly more than a hundredth of an inch in length, that their destruction is very difficult. In Europe infected ground is sowed with cowpeas, or some crop upon which the nematodes are especially bad, and the roots are all pulled up and burned. If this is repeated a few times most of them may be destroyed. Freezing and the free use of salt may also kill many of them. Another way is to starve them out by permitting nothing to grow on infected land or only such plants as are not susceptible to their attacks. This plan, followed by careful rotation of crops, will be found the most practical in a large way. For nursery stock, planting in new ground or sterilizing the soil by heating may be found profitable. Of course, no plant already infected should be planted.

No chemical means of treatment are yet known, except the use of salt as stated above. (*Ala. B. 9, B. 21; Fla. B. 9; N. J. R. 1890, p. 366, 518; N. Y. Cornell B. 43.*)

Nevada Station, Reno.—Organized January 2, 1888, under act of Congress of March 2, 1887, as a department of Nevada State University. The staff of the station consists of the president of the college and director, entomologist and botanist, agriculturist and horticulturist, chemist, librarian, and foreman of farm. The principal lines of work are soils, field crops, horticulture, diseases of plants, entomology, and dairying. Up to January 1, 1893, the station had published 18 bulletins and 4 annual reports. Revenue in 1892, $15,066.

New Hampshire Station, Durham.—Organized under act of Congress February 22, 1888, as a department of the New Hampshire College of Agriculture and Mechanic Arts. The staff consists of the president of the college, director, superintendent of dairying department, bacteriologist, two chemists, meteorologist, entomologist, assistant chemist, foreman of farm, and clerk. The principal lines of work are chemistry, experiments with field crops, feeding experiments, and dairying. Up to January 1, 1893, the station had published 2 annual reports and 17 bulletins. Revenue in 1892, $15,000.

New Jersey College Station, New Brunswick.—Organized under act of Congress in 1888 as a department of Rutgers College. The staff of the station consists of the president of the college, director, biologist, chemist, assistant chemist, superintendent of college farm, disbursing clerk and librarian, and mailing clerk. The principal lines of work are botany, diseases of plants, weeds, feeding experiments with milch cows, and entomology. Up to January 1, 1893, the station had published 4 annual reports and a number of bulletins in the same series as those issued by the New Jersey State Station. Revenue in 1892, $15,000.

New Jersey State Station, New Brunswick.—Organized under State authority March 18, 1880. The staff consists of the director, three chemists, chief clerk, and a laboratory attendant. The principal lines of work are chemistry, analysis and control of fertilizers, and field experiments with fertilizers. Up to January 1, 1893, the station had published 10 annual reports and 133 bulletins. Revenue in 1892, $11,000.

New Mexico Station, Las Cruces.—Organized under act of Congress, November 14, 1889, as a department of the Agricultural College of New Mexico. The staff consists of the president of the college and director, horticulturist and agriculturist, two chemists, entomologist and zoölogist, assistant agriculturist and horticulturist, assistant meteorologist, and clerk. The principal lines of work are field experiments with field crops, vegetables, and fruits, and entomology. Up to January 1, 1893, the station had published 2 annual reports and 9 bulletins. Revenue in 1892, $15,071.

New York Cornell Station, Ithaca.—Organized in February, 1879, by the faculty of agriculture of Cornell University, and reorganized under act of Congress, October 26, 1887, as a department of Cornell University. The staff of the station consists of the president of the university, director and agriculturist, deputy director and secretary, treasurer, chemist, veterinarian, botanist and arboriculturist, entomologist, horticulturist, cryptogamic botanist, assistant entomologist, two assistant agriculturists, two assistant horticulturists, assistant chemist, and foreman of farm. The principal lines of work are experiments with field crops, field and greenhouse experiments with vegetables and fruits, feeding experiments, entomology, and dairying. Up to January 1, 1893, the station had published 4 annual reports and 49 bulletins. Revenue in 1892, $15,300.

New York State Station, Geneva.—Organized under State authority, March 1, 1882. The staff consists of the director, first assistant, five assistant chemists, horticulturist, assistant horticulturist, and agriculturist. The principal lines of work are chemistry, meteorology, analysis and control of fertilizers, field experiments with fertilizers, field crops, vegetables, and fruits, diseases of plants, composition of feeding stuffs, feeding experiments, and dairying. Up to January 1, 1893, the station had published 10 annual reports and 133 bulletins. Revenue in 1892, $68,500.

New Zealand flax.—See *Flax*.

Nitrate of soda.—See *Fertilizers*.

Nitrogen.—See also *Fertilizers* and *Feeding farm animals*. Nitrogen in the free or gaseous state constitutes about one-fifth of the atmosphere surrounding the earth; about 3 per cent of the live weight of animals is nitrogen combined largely as albuminoids or protein compounds; and of all plants it is a prominent and important constituent.

The nutritive value of all animal and vegetable foods depends largely upon the organic combinations of nitrogen which they contain. These nitrogenous or albuminoid constituents of foods are considered specially necessary to the formation of muscle, tendon, and ligament in animals. Their composition and digestibility are therefore of great importance from the standpoint of animal production. The albuminoids are very variable in composition—Osborne has isolated and studied four distinct albuminoids from the corn kernel and five or more from the oat kernel (*Conn. State R., 1890, p. 114, R. 1891, p. 136*)—but all show a high percentage of nitrogen—16 per cent may be considered a fair average. The proportion of nitrogen differs widely in different plants, in different parts of plants, and in the same plant at different stages of growth. The leguminous plants are especially rich in nitrogen; immature plants are as a rule richer than mature, and seeds than stems and leaves. (See *Appendix, Table I*).

The nutritive value of protein has been the subject of much investigation by the stations. For résumés of this work, see *Foods*, *Feeding farm animals*, etc.

Nitrogen is of no less importance as an element of plant food. Notwithstanding its comparative abundance in nature, it is the most costly fertilizing ingredient which has to be supplied to soils. This is due to the comparative rapidity with which the organic nitrogen in the soil is reduced to the inert gaseous form by putrefactive ferments or is transformed by the process of nitrification into soluble compounds for which the soil has very slight retentive power (*Ind. B. 33*) and which are thus readily washed out by the drainage water.

SOURCES OF NITROGEN IN SOILS.—The nitrogen of soils is derived from the residues of former animal and vegetable life, from the fixation of free nitrogen by organisms of the soil, and from nitrogenous compounds absorbed by the soil from the air or washed down by rain and snow, and exists in three different forms, (1) ammonia, (2) nitrates, and (3) nitrogenous organic matter. The amount of ammonia is usually insignificant, the nitrates occur in larger amounts, sometimes amounting to as much as 5 per cent of the total nitrogen, but the great bulk of the nitrogen is in combination with organic matter.

Recent investigations have shown that the fixation, transformation, and in some plants at least, the assimilation, of nitrogen is promoted or controlled by the vital activity of microscopic organisms in the soil. These different processes will be discussed briefly under separate heads.

FIXATION OF NITROGEN BY SOILS.—Certain lower orders of plants and other microscopic organisms have the power of assimilating the free nitrogen of the air and of converting it into organic combinations. The accumulation of the remains of these organisms in the soil materially increases its content of nitrogen. Besides this, the natural absorptive power of a soil enables it to acquire a small quantity of the combined nitrogen of the air.

NITROGEN CARRIED DOWN TO THE SOIL IN RAIN AND SNOW.—The extent of the supply from rain water is indicated by the following tabular statement of results tained at the Kansas Station (*R. 1889, p. 131*):

Summary of results of analyses of rain water.

[Mean rainfall for 4 years, 29.14 inches.]

	Parts per million of water.	Pounds per acre.
Total nitrogen—means for 4 years	0.522	3.44
Nitrogen in ammonia—means for 3 years	0.388	2.63
Nitrogen in nitric acid—means for 3 years	0.156	1.06

Observations at Rothamsted, Lincoln (New Zealand), and in Barbados, show that 3.37, 1.74, and 3.77 pounds of nitrogen per acre, respectively, were brought down in rain, snow, etc., annually. The amount is small, but by no means insignificant. It is evident, however, "that if the ammonia and nitric acid of the air are to be of any considerable agricultural importance they must be taken up directly by crop or soil to an extent far beyond that which takes place through the medium of rain. The amount of ammonia and nitric acid in the air is certainly extremely small, but the air that is in contact with crop and soil is being constantly renewed. It is, therefore, by no means impossible that the quantities absorbed may become considerable."—(Warrington.)

NITRIFICATION, OR TRANSFORMATION OF ORGANIC NITROGEN INTO NITRATES.—The vast niter beds of Peru, Chile, and other countries, are the result of the activity of microörganisms, three distinct classes of which probably take part in the formation of the nitrate; one converts the organic matter in ammonia, a second changes this ammonia into nitrites, and the third transforms the nitrites into nitrates.

Nitrification goes on in all warm, moist, alkaline soils, but it is only in regions of limited rainfall that the nitrates accumulate, as in the niter beds of Chile. In regions of abundant rainfall the nitrates are washed out by the drainage water. According to Dehérain the annual loss in well-drained fallow land may amount to as much as 294 pounds of nitrate of soda per acre.

Denitrification.—As opposing the process of nitrification in the soil, there are certain organisms which reduce nitrates to other lower forms less available to plants. These are known as denitrifying organisms, and are especially active when there is a limited supply of air in the soil, as in case of water-logged soils. The remedy for this, therefore, is drainage and improvement of the texture of the soil, thus facilitating the circulation of air.

Assimilation of nitrogen by plants by means of microörganisms (symbiosis).—Recent investigations have shown that certain organisms infesting the roots of leguminous plants have the power of rendering the nitrogen of the air available to those plants (see *Green manuring* and *Leguminous plants*).

Sources of nitrogen in fertilizers.—The chief sources of nitrogen in fertilizers are the salts—nitrate of soda and sulphate of ammonia—and the organic substances—dried blood, cotton-seed meal, castor pomace, dry ground fish, tankage, etc.

"Nitrate of soda is mined in Chile and purified there before shipment. It usually contains about 16 per cent of nitrogen, equivalent to 97 per cent of pure nitrate of soda. It contains besides a little salt and some moisture. The usual guaranty is '96 per cent' of nitrate of soda, equivalent to 15.8 per cent of nitrogen.

"Sulphate of ammonia, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent of nitrogen, the equivalent of from 94 to 97 per cent of sulphate of ammonia. The rest is chiefly moisture. The usual guaranty is 25 per cent of ammonia, which is equivalent to 20.6 per cent of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity." (*Conn. State R., 1891, p. 27.*)

For the composition of the other sources of nitrogen in fertilizers see *Appendix, Table IV.*

Best form of nitrogen to apply as a fertilizer.—It is probable that plants take up nitrogen through their roots exclusively in the form of nitrate. Consequently, when nitrate is applied to soils it is immediately available to plants. Other forms have to undergo the processes of nitrification already explained. In the case of sulphate of ammonia and of other ammonium compounds, the transformation to nitrates is one stage further (ammonia stage) advanced than in case of organic matter.

Classifying the nitrogenous fertilizers, therefore, according to the readiness with which they will be utilized by plants the order would be as follows: (1) Nitrates, (2) ammonium salts, (3) organic nitrogenous substances. In the third class there is a wide difference between such substances as the readily decomposable dried blood and the almost inert ground leather, even though they might be equally rich in nitrogen. (For methods of determining availability of nitrogen in fertilizers, see *Fertilizers.*) It may be said in favor of the organic forms of nitrogen, that in the majority of cases they are transformed as fast as needed by most crops, and thus are less liable to loss in drainage, are more lasting in effect, and do not hasten the growth of vegetative organs at the expense of fruit. Incidentally, their organic residues improve the chemical and physical character of the soil.

For the reasons above explained, nitrate of soda has been found especially valuable for hastening the early growth of crops, and has generally given the best results when applied fractionally. Sulphate of ammonia, while less liable to leaching, has been found slow of action in the early spring when conditions are unfavorable to nitrification (*Mass. R. 1892, p. 173; R. I. R. 1891, p. 80*). In the warmer regions of the United States, where conditions are generally favorable to rapid decomposition in the soil, the difference in effectiveness of the different forms of nitrogen is not so marked and the organic forms of nitrogen have been found particularly effective.

In experiments on corn and cotton at Georgia, Louisiana, and South Carolina Stations (*Ga. B. 11, B. 15, B. 16; La. B. 26, B. 27, B. 28, and B. 8, B. 16, B. 21, 2d ser.; S.C. R. 1888, p. 246, R. 1889, p. 292*), on sugar cane at Louisiana Station (*B. 20, B. 28, B. 21, 2d ser.*), and on tobacco at Virginia Station (*B. 12*) the results in general indicated that the organic forms of nitrogen were as effective as the more soluble forms. The results of a special study of the availability of different forms of nitrogen to the corn plant are given in *Pa. R. 1889, p. 195*.

SPECIAL NITROGEN EXPERIMENTS.—Special experiments with nitrate of soda on various crops have given interesting results. The tendency of nitrate of soda to increase the growth of stems and leaves at the expense of grain or seed is brought out in experiments at the Minnesota Station (*R. 1888, p. 159*) on wheat, oats, barley, mangel-wurzels and clover. In case of clover it prevented the production of seed entirely, and in every case largely increased the growth of the vegetative organs. Similar results were obtained at the Ohio Station (*R. 1888, p. 109*) with strawberries. On the other hand, experiments at the New Jersey Station (*R. 1891, p. 141*) on strawberries showed an increase of 31 per cent in yield of fruit due mainly, however, to the increased size of the berries and not to an increase in their number.

Experiments with nitrate of soda on tomatoes at the New Jersey Station carried on for three years (*B. 63, B. 79, B. O, R. 1891, p. 85*) led to the following conclusions, especially applicable to early tomatoes:

(1) Maximum yields of tomatoes depend upon a full supply of immediately available nitrogen; (2) nitrogen in itself is not a complete fertilizer; and (3) to economically use commercial manures the farmer must know the average capacity of his soil for the crop.

"The average results secured under the varied conditions of soil and season included in the three years of experiment, seem, however, to warrant a further practical conclusion, viz: That under the conditions considered favorable for the growth of tomatoes—that is, good cultivation and previous liberal fertilization—the application of 160 pounds per acre of nitrate of soda alone will be uniformly more profitable for early tomatoes than combinations of minerals, barnyard manure, or a complete fertilizer."

These results are generally confirmed by similar experiments at the Maryland Station (*R. 1891, p. 412*) and at the New York Cornell Station (*B. 32*). From the latter the conclusion was reached that nitrate of soda should be used alone on poor soils, and "that nitrate gives better results when applied two or three times than when the same amount is applied at once."

Experiments on potatoes, timothy, and sweet potatoes indicate that nitrate of soda is a valuable fertilizer for those crops. (*N. J. B. P, R. 1890, pp. 122, 149, 150.*)

The following directions for the use of nitrate of soda on wheat are drawn from experiments at New Jersey Station (*B. 80, R. 1890, p. 142*):

"When the crop has not been fertilized in the fall, 100 pounds per acre would probably be more profitable than larger amounts.

"If the soil contains an excess of potash and phosphoric acid which has been applied to previous crops or directly, the amount can be safely increased to 150 or 200 pounds per acre.

"All lumps should be crushed and the application to the soil made as evenly as possible. In order to accomplish this it may be advisable to mix earth with the nitrate.

"The best time to make the application is after the plants have obtained a fair start in the spring. If possible, it should be applied before a light rain; this will insure complete distribution in the soil."

METHODS OF DETERMINING NITROGEN.—In *Conn. State R. 1889, p. 191*, apparatus for the Kjeldahl method is described and illustrated. *Conn. State B. 112* contains a report on a modification of the Gunning-Kjeldahl method applicable to nitrates. The Schulze-Tiemann method for nitric acid is described and discussed in *Conn. Storrs*

R. 1890, p. 163, and modifications based on experimental data proposed. A modification of the Kjeldahl-Jodlbauer method for nitrogen in nitrates is proposed in *Mc. R. 1888, p. 204.* A method of determining nitrogen by the azotometric treatment of the solution resulting from the Kjeldahl digestion is described in *N. Y. Cornell B. 6.* Favorable results of a test of a modification of the official method for determining albuminoid nitrogen, consisting essentially of an increase of the amount of potassium sulphide solution used from 20 c. c. to 30 c. c., are reported in *N. Y. Cornell B. 37.* In the same bulletin experimental data are cited to show that it is not advisable to use the modified Kjeldahl method for determining the total nitrogen in soils, but that more satisfactory results are obtained by a separate determination of the nitrates and nitrites.

North Carolina Station, Raleigh.—Organized under State authority March 12, 1877, and reorganized under act of Congress in 1887. The staff consists of the director and chemist, agriculturist, botanist and entomologist, horticulturist, meteorologist, four assistant chemists, assistant agriculturist, assistant meteorologist, and secretary. The principal lines of work are chemistry, meteorology, analysis and control of fertilizers; field experiments with fertilizers, field crops, vegetables, and fruits; seed testing; and analyses of feeding stuffs. Up to January 1, 1893, the station had published 12 annual reports and 115 bulletins. Revenue in 1892, $23,400.

North Dakota Station, Fargo.—Organized under act of Congress March 8, 1890, as a department of North Dakota Agricultural College. The staff consists of the president of the college and director, chemist, agriculturist, veterinarian, arboriculturist, botanist, farm superintendent, assistant horticulturist, assistant chemist, and secretary. The principal lines of work are botany, field experiments with field crops, forestry, and diseases of plants. Up to January 1, 1893, the station had published 2 annual reports and 8 bulletins. Revenue for 1892, $17,887.

Nutritive ratio.—See *Feeding farm animals.*

Oak trees (*Quercus* spp.).—Several American and two foreign members of this important genus have received notice at the stations. According to the South Dakota Station (*R. 1888, p. 24*), "every planter should put acorns into his tree claim." They make little show the first few years, but when the roots are well formed they advance more rapidly. On account of their taproot they are difficult to transplant, though, according to *Minn. B. 24,* "nursery grown trees properly handled can be moved without serious loss." At the last given reference the bur, mossy-cup, or over-cup oak (*Q. macrocarpa*) is recommended as "our finest ornamental oak, and a magnificent tree even in the most severe locations." "This tree and the white oak class, to which it belongs, have very long taproots," and hence withstand the treading of cattle or the working of the soil around them far better than the red oak class, which have mostly surface roots, though if planted in open ground those also develop taproots. The bur oak is characterized in *S. Dak. B. 23* as "one of the most valuable species of the entire oak family." It is very durable when in contact with the soil, and can be substituted with advantage for the more commonly used white oak in all cases." It is native in Minnesota and South Dakota, and, according to *Nebr. B. 18,* it is the most widely distributed oak in that State, and "in favorable situations attains a great size, even along its western borders." The valuable but less ornamental white oak (*Q. alba*) is noted in *Cal. R. 1880, p. 68; Minn. B. 24; S. Dak. R. 1888, p. 24.* The red oak (*Q. rubra*) is characterized in *Minn. B. 24* as "a good ornamental and timber tree, with foliage of a deep red color in autumn," and the scarlet oak (*Q. coccinea*) as a beautiful ornamental tree, having brilliant scarlet foliage after the first frosts of autumn. The jack or black oak (*Q. nigra*) is mentioned in *S. Dak. B. 23* as inferior to bur oak, but growing much more rapidly when young.

In California eastern oaks have been planted, which in general have been found to grow very slowly (*Cal. R. 1880, p. 68*). The tanbark oak (*Q. densiflora*), native in

that State, is noted in *Cal. R. 1881–'82, p. 108, R. 1884, p. 72,* as an important source of tanning material, but in danger of exhaustion.

In *Ga. B. 2* are presented the results of an investigation of the fuel value of white oak, red oak, and post oak (*Q. obtusiloba*), including full ash analyses of the wood and the bark. (See *Appendix, Table V.*)

In California two foreign oaks have come to be of importance. The English or German oak (*Q. robur*) has been tested widely in the State, and unlike the American oaks, when transplanted to that climate, "proves to be a rapid grower, unexpectedly resistant of drought, and promises well as the hard-wood tree of the future on the Pacific Coast. It is not choice as to location, and would probably do well both on the mountains and in the plains, where the latter are not too dry." (*Cal. B. 29.*) As noted in *Cal. R. 1890, p. 231,* however, it is better adapted to the coast region than to other localities. "The tree requires a deep soil, heavy loam being preferable to a light sandy soil." On account of the long taproot which it soon sends down, the sapling should be removed at the age of one year, or better, the acorn should be planted where the tree is to stand. (*Cal. B. 50, B. 81, B. 95, R. 1880, p. 68, R. 1885–'86, p. 121.*)

The cork oak (*Q. suber*) has been planted in numerous localities in California, and large specimens are known to exist in at least six different counties. Although of slow growth, it was judged (*Cal. R. 1885–'86, p. 121*) to offer "a promising investment to those who can afford to wait some time for returns." It was found to grow in a soil ill-suited to most other trees, for instance, in clay and even in ill-drained soil. While a large part of the State is eminently adapted to oak plantations, it was judged that the cork oak would probably grow faster in the warmer districts, and it is particularly recommended for the Sierra foothills (*Cal. R. 1890, p. 231*). It is stated to be very hard to transplant. (See also *Cal. B. 81.*)

Oat grasses.—See *Grasses.*

Oats.—Almost all the cultivated varieties belong to the species *Avena sativa.* Classified lists of the cultivated species and varieties have been published in *Ill. B. 12; N. Y. State R. 1884, p. 390, R. 1886, p. 100.* The work of the stations on this cereal has included tests of varieties, analyses, experiments in methods of planting, rate, time, and depth of seeding, tests of fertilizers, and feeding experiments.

VARIETIES.—Some twenty-five of the stations have reported tests of varieties of oats, in a number of cases extending through a series of years. Among the varieties which have given relatively large yields in different localities are the following: Schoenen, Probsteier, Improved American, Black Tartarian, Rust Proof, Surprise, Wideawake, Welcome, White Belgian, White Russian, Clydesdale, Japan, White Victoria, White Seisure, Barley, and Early Dakota. Out of thirteen varieties grown for hay at the Kansas Station, Blue Grazing Winter gave the largest yield, 4.85 tons per acre (*Kans. B. 29*). The Illinois Station (*B. 19*) makes the following general statements regarding the varieties tested there:

"The early-maturing varieties are superior to either the medium or late in the average yield of both grain and straw, the weight per bushel, and size of berries, but are inferior to either of these in per cent of kernel. As to berries (short plump and long slender), there is very little difference in yield, a noticeable difference in weight per bushel in favor of the short plump, and a difference of 2.1 per cent in kernel in favor of the long slender.

"The white berries gave the largest yield of grain and the smallest per cent of kernel. The dun-colored gave the smallest yield and the largest per cent of kernel.

"As to panicles, open or closed, the latter is superior in yield of both grain and straw and also in per cent of kernel.

"As to weight per bushel, those which weigh less than 32 pounds are superior in both yield and per cent of kernel. Notwithstanding the common belief to the contrary, those oats which weigh least to the bushel have usually the highest per cent of kernel, and consequently the highest food value."

The Wisconsin Station has called attention to important differences between varieties as regards the weight of the hulls (*Wis. B. 17*).

(*Ala. Canebrake B. 5; Cal. R. 1890, p. 274; Colo. R. 1890, pp. 15, 185, 204, and 207; Fla. B. 14; Ga. B. 14; Ill. B. 12, B. 19; Ind. B. 6 (1886), B. 14; Iowa, B. 15; Kans. B. 13, B. 29, R. 1889, p. 52; Ky. B. 23, B. 35; Me. B. 18 (1887); Mass. Hatch. B. 11, B. 18; Mich. B. 34, B. 46; Mo. B. 15; Nebr. B. 6, B. 17; Nev. R. 1891, p. 13; N. Y. State B. 102, B. 4, n. ser., R. 1884, p. 390, R. 1886, p. 100; Ohio B. vol. III, 3, B. vol. V, 1; Ore. B. 4; Pa. B. 6, B. 10, R. 1889, p. 21, R. 1890, p. 149; S. C. B. 5 (1889), B. 4, n. ser., R. 1889, p. 205; S. Dak. B. 11, B. 17, B. 21; Tenn. B. vol. III, 2; Wis. B. 13, B. 17, B. 22.*)

COMPOSITION.—See *Appendix, Tables I and II.*

CULTURE.—Experiments in growing oats on rolled and unrolled land at the Wisconsin Station (*R. 1890, p. 120*) and six other localities in the State give the following average results: Rolled ground, 61.12 bushels per acre, weighing 28.35 pounds per bushel. Unrolled ground, 58.89 bushels per acre, weighing 26.32 pounds per bushel. At the Kansas Station (*B. 29*) the use of the roller or press wheel is favored. At the same station (*B. 13*) good results are reported in one case from planting on unplowed land; in another case fall plowing was more advantageous than spring plowing or no plowing (*Kans. B. 29*). The New York State Station (*R. 1889, p. 294*) reports an experiment in which subsoiling was somewhat beneficial to oats. In Illinois a seed bed of medium compactness gave the best results during several seasons (*Ill. B. 12*).

In Illinois it was found better to sow oats before the first of April rather than later (*Ill. B. 3, B. 12*). In Louisiana oats can be profitably sown for forage early in October. In one experiment in that State it was observed that the oats sown in October were not killed by the cold in January as were those sown in November (*La. B. 4*). At the New York State Station (*R. 1887, p. 69*) fall sowing was not successful, but oats sown February 10 on land where wheat had failed to grow produced a good crop.

A number of stations report experiments which favor drilling rather than sowing broadcast (*Ind. B. 6, B. 14; Kans. B. 13; Nebr. B. 17; Ohio B. vol. V. 1; R. I. R. 1890, p. 15; S. Dak. B. 17, B. 21*). In one experiment at the Illinois Station only 44 per cent of the oats sown broadcast in the field grew, and the average number of stalks in each stool was less than two (*Ill. B. 3*).

The proper depth of seeding in an average season would seem to be about 2 inches (*Ill. B. 3, B. 12, B. 19; N. Y. State R. 1887, p. 66; Ohio B. vol. V, 1.*)

From 2 to 3 bushels of seed per acre will probably as a rule give the best results (*Ala. College B. 6 (1887); Ill. B. 3, B. 12, B. 19; Ind. B. 6, B. 14; Kans. B. 29; Ohio B. vol. III, 3; S. Dak. B. 17*).

In an experiment at the Kansas Station (*B. 29*) a larger yield was obtained by cutting oats in the dough state than by letting them stand until ripe.

When oats and peas are grown together for forage, the Minnesota Station (*B. 11*) advises that the seed be mixed in proportions of one part of oats to three parts of peas.

FERTILIZER TESTS.—The experiments thus far reported agree, in general, in indicating the desirability of having nitrogen in the fertilizer applied to oats, and in many cases the addition of phosphoric acid has proved beneficial. In some experiments nitrate of soda has given the best results and in others cotton-seed meal. The Indiana Station reports in favor of barn-yard manure as compared with commercial fertilizers (*Ind. B. 34*). In experiments in South Carolina on sandy and clayey soils, nitrogen in an unorganic form was found most beneficial to oats. Nitrogen and phosphoric acid were needed on these soils, but potash was of doubtful value (*S. C. B. 5, R. 1889, p. 198*). At the Georgia Station (*B. 14*) on gravelly soil with hard red clay subsoil, cotton-seed meal was the only profitable fertilizer. In Massachusetts nitrate of soda alone in small quantities proved beneficial (*Mass. Hatch. B.*

18). At the Ohio Station (*B. vol. V, 3*) the increase in yield was more uniform when the fertilizer contained nitrogen. Analyses of oats grown with different fertilizers at the New York State Station indicated the most marked effects from nitrate of soda. Nitrogen seemed to increase the size of the straw and retarded ripening, while phosphoric acid hastened ripening (*N. Y. State R. 1888, pp. 262, 344*). At the Massachusetts State Station (*R. 1890, p. 149*) it was observed that where nitrogen was omitted from the fertilizers for oats, not only was the yield decreased but the foliage of the plants had a light green color throughout the season. "In the majority of cases where muriate of potash has furnished the potash, the maturing of the crop was somewhat later than where sulphate of potash was used." On alluvial soil in Louisiana, cotton-seed meal and acid phosphate greatly increased the yield of oats (*La. B. 4*). The same station reports that peas grown before oats increased the yield of the latter even when the pea vines were removed before plowing (*La. B. 11*). At the Kansas Station (*B. 29*) the application of salt as a fertilizer somewhat decreased the yield o. oats. The greater effect of fertilizers on drained than on undrained land has also been noticed (*Ala. Canebrake B. 5; La. B. 26*).

FEEDING EXPERIMENTS.—See *Cows; Cattle, feeding for beef and for growth;* and *Pigs.*

Oats, black or loose smut (*Ustilago avenæ*).—A well-known fungous disease which appears about the time the grain heads out, and transforms the whole head into a black powdery mass of innumerable spores. The smut matures about the time of blooming, and the ripened spores are scattered by the wind, leaving the bare stalk standing at harvest time. The smut germinates the following season when the seed sprouts, early penetrates the oat plant, and develops with it. It shows its presence only when it reaches the head. Numerous experiments show that the smut is sown with the oat seed. It adheres closely to the grain, and can only be seen by the most careful inspection. Numerous unsuccessful attempts have been made to infect plants after they had made considerable growth. Anything which will prevent the germination of the spores adhering to the seed oats will prevent the smut. One form of treatment is to soak the seed for twenty-four hours in a solution of potassium sulphide (1 pound to 20 gallons of water), or to use twice as much of the chemical and soak half as long. Carefully dry, and sow at once. Another means is the Jensen, or hot-water, treatment. This consists in placing the seed oats in water heated to 132½° F. for fifteen minutes, care being taken that the temperature does not fall below 130° nor rise above 135°. For full directions for these methods of treatment, see *Fungicides*. The use of either of these methods not only insures exemption from smut, but actually increases the crop of both grain and straw. Seed from fields where there is no smut does not need treatment, unless the smut is in other fields near by.

Loose smut is also found upon wheat and barley, where the same treatment should be given as for oats. (*Ind. B. 28, B. 35; Kans. B. 8, B. 15, B. 22, R. 1889, p. 213; Mass. State R. 1891, p. 244; Nebr. B. 11; S. Dak. B. 17; N. Y. State B. 97; R. I. B. 15; Vt. R. 1890, p. 138*).

Odorless phosphate.—See *Phosphates.*

Office of Experiment Stations, Washington, D. C.—Organized October 1, 1888, as a branch of the United States Department of Agriculture to represent the Department in its relations to the agricultural experiment stations in the several States and Territories. Its object is to promote uniformity of methods in the work of the stations, and in general to furnish them such advice and assistance as will best promote the purposes for which they were established. To this end it indicates lines of inquiry, aids the stations in the conduct of coöperative experiments, helps to make available to them the processes and results of experimental inquiry in the United States and abroad, and compiles, edits, and publishes accounts of station investigations. It also acts as a bureau of information for the general public on all matters connected with the work of the stations in this and other countries. The

administrative and editorial force of the office consists of a director; assistant director and editor of departments of botany, field crops, and horticulture; special editor for foreign work; editors of departments of chemistry, foods and animal production, and dairying; fertilizers, soils, and indexes; seeds, weeds, and diseases of plants; and librarian and record clerk. The office has issued 14 bulletins, 3 miscellaneous bulletins, 4 farmers' bulletins, and 4 volumes of the Experiment Station Record (see pp. 4 and 126).

Ohio Station, Wooster.—Organized at Columbus under State authority April 25, 1882, reorganized under act of Congress April 2, 1888, and removed to Wooster September 1, 1892. The staff consists of the director, vice-director and horticulturist, agriculturist, entomologist, chemist, and assistant horticulturist. The principal lines of work are field experiments with fertilizers, field crops, vegetables and fruits, and entomology. Up to January 1, 1893, the station had published 11 annual reports and 47 bulletins. Revenue in 1892, $22,116.

Oklahoma Station, Stillwater.—Organized under act of Congress June 23, 1891, as a department of Oklahoma Agricultural College. The staff consists of the president of the college, director, agriculturist and horticulturist, chemist and physicist, and superintendent of farm. The principal lines of work are field experiments with field crops, vegetables, and fruits. Up to January 1, 1893, the station had published 4 bulletins. Revenue in 1892, $15,000.

Okra (*Hibiscus esculentus*) [also called Gumbo].—An annual plant bearing numerous edible pods. Tests of varieties are reported in *Nebr. B. 12; N. Y. State R. 1885, p. 189, R. 1886, p. 249, R. 1888, p. 130.* The rooting habit of okra was observed at the New York State Station (*R. 1886, p. 159*) and found not to be specially shallow, though the plant is of tropical origin.

Germination tests of okra seed are reported in *N. Y. State R. 1883, pp. 60, 69; Ohio R. 1885, p. 168; S. C. R. 1888, p. 79; Vt. R. 1889, p. 106.*

Olive (*Olea europæa*)—This fruit appears to have been studied at the California Stations only; but there, owing to the increasing prominence of its culture in the State, a thorough investigation of its varieties, etc., has been undertaken. Experimental plantations are noted in *Cal. R. 1889, pp. 87, 111, 137, 187, 196, B. 85 (R. 1890, p. 150), B. 91, B. 92 (R. 1890, p. 167).*

In *Cal. B. 85* a record of several years' growth of a number of varieties is given and the same are described, especially with relation to the ratio of the pit to the pulp by bulk.

Less complete data are given upon a number of other varieties. Notes are made also upon some seedling olives grown on the Berkeley experiment grounds. *B. 91* contains brief descriptive notes on 8 varieties of olives recently imported. *B. 92 (R. 1890, p. 167)* presents a study of olive varieties in which time of ripening and productiveness and the quantity and quality of the oil were observed.

The investigation of the proportion of kernel to meat in the fruit showed a variation of from 8 to over 34 per cent for the kernel in different varieties, a matter considered of much importance with respect to the production both of oil and pickled olives.

In studying the manuring of the olive, ash analyses were made (*B. 85*) of the wood of large and of small branches, of leaves, and of fruit. Determinations of nitrogenous matter are also given. (For wood and fruit analyses see *Appendix, Table III*). The fuel value of olive oil and other fats, etc., was investigated with the calorimeter at the Connecticut Storrs Station (*R. 1890, p. 182*).

A general discussion of olive culture, arguing its importance, and treating of varieties, soil, propagation, time of bearing, and enemies may be found in *Cal. R. 1885–'86, p. 109.*

The manuring of olives is considered with some fullness in *Cal. R. 1890, p. 162.* The view of some authors that the olive grows and bears best on the most barren ground is rejected. Analyses are given showing an abundance of potash in the wood, in

the leaves, and especially in the fruit; also a good quantity of lime and phosphoric acid. In general the quantity of oil is in proportion to the potash. California soils are considered to be "very well adapted to olive culture, provided we increase, by the use of manure, their proportion of nitrogen and phosphoric acid in localities where these ingredients are deficient."

The olive in a soil which suits it does not need much manuring, and excessive manuring, while it increases the yield, injures the quality of the oil. Instructions are given as to the time and mode of manuring.

In *Cal. R. 1890, p. 159* is a paper upon the ripening, picking, assorting, and conservation of olives.

The effects of different soils and climates on ripening are noted, and the proper condition of the fruit for picking. If high quality of the oil is the object, the olives must be gathered when they show the black-velvety color in cold climates, but in warm climates, while still yellowish; if quantity is sought, they can be gathered at full maturity. "Very unripe olives furnish a bitter oil; those which are nearly ripe give an oil which has a fruity taste, and, everything considered, is better than any of the others; olives which are completely ripe produce an oil with a strong flavor, which is hardly agreeable and is subject to becoming rancid; over-ripe olives yield a very greasy, thick oil, which is very difficult to keep from spoiling." Picking by hand is strongly urged. The olives must be carefully protected from bruising, and should be sorted into four different qualities, which are named. The olives ought to be kept in any case as short a time as possible; all which are not in the best condition must be crushed at once. "The only good method of preservation is to make use of trays on shelves of willow or cane." Directions are also given for pickling olives. The modes of preparation, it is stated, can be reduced to two—one using a lye of greater or less strength, the other pure water only. The details of the methods are explained.

In *Cal. R. 1890, p. 173,* olive oil is considered with special reference to purity and methods of testing for adulteration. The method by iodine absorption is described, but it is not considered wholly reliable, and a method adopted at the laboratories of the Italian custom-houses is described, employing a solution of nitrate of silver as a test against cotton-seed oil. Several other reactions serving as tests against seed oils are described.

Onion (*Allium cepa*).—This vegetable has been the subject of many variety tests, of culture and fertilizing experiments, and of a few other inquiries. Tests of varieties are reported as follows: *Ala. College B. 20, n. ser.; Colo. R. 1888, pp. 118, 121, R. 1889, pp. 40, 98, R. 1890, pp. 50, 192; Ind. B. 18; Ky. B. 38; La. B. 3, 2d ser.; Md. B. 5; Minn. B. 10; R. 1888, pp. 236, 261, Nebr. B. 6, B. 12, B. 19; N. Y. State R. 1882, p. 125, R. 1883, p. 183, R. 1884, p. 200, R. 1885, p. 119, R. 1886, p. 236, R. 1887, p. 318, R. 1889, p. 330; Ohio B., Vol. III, 9; Pa. B. 14; Va. B. 11. In N. Y. State R. 1888, p. 190,* a classification is given of 54 varieties on the basis of the form and color of the bulb. Full descriptions with English and foreign synonyms are given, and an index of the names. The potato onion and top onion are noted at the close of the list. Information respecting the top onion is also given in *Minn. R. 1888, p. 258.*

An ash analysis of onions is given in *Mass. State R. 1890, p. 305, R. 1891, p. 331* (see *Appendix, Table III.*)

The root system of the onion was observed at the New York State Station (*R. 1884, p. 310, R. 1886, p. 161*) and was found to be very compact. The roots radiated in all directions below the surface and reached a length of 16 or 18 inches.

The plan of sowing seed in the greenhouse and transplanting to the field was tested through three seasons at the Ohio Station (*B. Vol. III, 9*) with results regarded quite favorable to the practice. The cost of growing a given amount of onions was actually lessened, while the crop was three or four weeks earlier and of finer appearance. The advantage, however, was considerably greater with foreign varieties adapted to a long season.

These experiments were independent of similar ones published by T. Greiner in 1889. Experiments tending to confirm this view are reported in *Mich. B. 79; R. I. B. 14; Va. B. 11.*

A trial of planting rows of onions at different distances is recorded, *N. Y. State R. 1882, p. 125;* of planting at different distances in the row, *N. Y. State R. 1883, p. 183; Ohio R. 1885, p. 128, R. 1887, p. 229.* At the New York State Station (*R. 1883, p. 184, R. 1884, p. 201*) a compact *vs.* a loose subsoil for growing onions was tested, the result in the first trial favoring the former, in the second the latter. At the Minnesota Station (*B. 10 R. 1888, p. 227*), trials upon soil plowed and harrowed and harrowed only, proved quite favorable to leaving the seed-bed compact. General notes on culture occur in *Va. B. 11.* Experiments with fertilizers on onions are reported in *Minn. R. 1888, p. 225; Ohio R. 1885, p. 126.*

Germination tests of onion seed are recorded in *Ala. College B. 2 (1887), Me. R. 1888, p. 140, R. 1889, p. 150; N. Y. State R. 1882, p. 125, R. 1883, pp. 60, 69, 183; Ohio R. 1883, pp. 170, 176, R. 1885, pp. 164, 175, R. 1886, p. 254, R. 1887, p. 284; Ore. B. 2; Pa. R. 1889, p. 164; S. C. R. 1888, p. 85; Vt. R. 1889, p. 107.* Tests of the quality of the stock of different seedsmen are reported in *Ohio R. 1884, p. 141, R. 1885, p. 125, R. 1887, p. 229.*

Onion, black mold (*Macrosporium* sp.).—A fungous disease appearing on the plants about the time they are in flower. At first spots appear upon the stems some little distance below the heads. These increase in size and become dark brown or black. There may be two or three points of attack upon the same stalk, and sooner or later it falls over, becoming worthless. This fungus often accompanies the onion mildew as a secondary phase, but that it is not dependent upon it is now well known. The black mold may be held in check by destroying all the infected plants and burning the dead leaves and stalks. (*Conn. State R. 1889, p. 158; N. J. R. 1890, p. 354.*)

Onion mildew (*Pernospora schleideni*).—A fungous disease, the presence of which is indicated by the appearance of small yellowish spots, from which the disease soon spreads and involves the whole plant. Upon the surface of the spots will be seen a mold-like coating, white near the edges and slightly red at the center. This is often accompanied by another fungus (see *Onion, black mold*). This disease is worse upon seed onions. Its attacks vary in severity. In some places but little damage is done, while in others hardly a seed pod is matured. The fungus survives the winter in the leaves and dead stalks, which, therefore, should be gathered and burned. The fungus is similar to the one causing the downy mildew of grape, and probably would yield to the same fungicides. (*Conn. State R. 1889, p. 155.*)

Onion smut (*Urocystis cepulæ*).—A fungous disease, the presence of which is first indicated by dark spots at various heights upon seedling plants. These spots are sometimes found upon the first leaf, before a second has begun to show itself. After a time longitudinal cracks begin to appear on one side of these spots, which widen and show within a dry, fibrous mass, covered with a black, sooty powder, the spores of which are blown away or washed into the ground. Sometimes the fungus will appear upon the tip of the leaf. If this dies, the fungus is cut off and the main part of the leaf remains free, but usually the disease spreads throughout the entire plant, destroying it. Some of the stronger plants may survive, but they will be found to have smut spots of various sizes on the bulbs. Such bulbs usually rot soon after harvesting. This disease infects seedling onions only, and it is generally considered that the spores are in the ground when the seed is sown. All diseased plants and refuse should be removed and burned. In this way the fungus may be kept in check to a certain degree. The spores retain the power of germination for an unusually long period—twelve or more years according to one authority. On this account onion growing should not be attempted for many years on ground once thoroughly infested. As yet no sufficient remedy is known. Sulphur and air-slaked lime (equal parts) in the drills has given favorable results in some cases. (*Conn. State B. 111. R. 1889, p. 129, 1890, p. 103; Mass. R. 1891, p. 247; N. J. R., 1890, p. 353; Vt. R., 1890, p. 141.*)

Onion vermicularia (*Vermicularia circinans*) [also called Leaf spot].—A fungous disease which attacks onions and sets, especially of the white kinds. It causes black blotches to appear upon the onion which are soon surrounded by concentric rings. The most serious attacks from this fungus are to be expected in the storehouse, where it spreads rapidly, often causing great damage. Onions should be stored in cool, dry, airy houses, and if free from the fungus when put in the bins they will remain so. Care must be taken to prevent moisture and heating. If the onions are diseased it may be held in check by treating them with air-slacked lime, 1 bushel to 25 of onions. Bins in which affected onions have been stored should be fumigated and thoroughly cleansed before again using. The main precaution necessary is to have the onions dry when put in the houses and to keep them so.

If affected onions have not begun to decay they may be used with safety for seed, but they may spread the disease late in the season to market onions if any should be near by (*Conn. State. R. 1889, p. 163; N. J. R. 1890, p. 354*).

Orach (*Atriplex hortensis*).—This herb, used like spinach and sometimes called French spinach, is described in *N. Y. State R. 1883. p. 208*, as a tall annual plant, with numerous broad, slightly blistered, soft, arrow-shaped leaves, which are used like those of common spinach. Red and white varieties were grown at the New York State Station (*R. 1883, p. 208*).

Orange (*Citrus* spp.).—Experimental plantations of oranges are noted in *Cal. R. 1888–'89, pp. 87, 110, 137, 196, R. 1890, pp. 280, 289, 294, 300; Fla. B. 1; N. Mex. B. 2; N. C. B. 72, B. 83, R. 1890, p. 20.*

In North Carolina trial was made of the *Citrus trifoliata*, and of the Japanese "Satsuma," "Oonshiu," or "Kiu seedless" orange, which was grafted upon stocks of the former. *C. trifoliata* (also noted in *Fla. B. 1*) is reported as fruiting freely in northern Maryland, and is hardy as far north as New York. Its fruit is ornamental and of some use for marmalade, and the tree is suggested as suitable for a hedge plant. The Satsuma, a sweet orange of the mandarin class, has been reported very hardy. Its leaves were killed at the North Carolina Station by a severe winter, but the wood seemed still sound.

In California the comparative physical and chemical composition of varieties has been investigated. Reports of examinations showing proportions of pulp and rind, and acid and sugar content, occur in *Cal. B. 39, Sup. R. 1878–'79, p. 59, R. 1880, p. 42, R. 1882, p. 63*, and especially *R. 1889–'90, p. 106* (*B. 93*). In the last reference it is stated that 23 samples, mostly of navel, Mediterranean sweet, St. Michaels, and Malta blood oranges were examined with reference to physical and proximate chemical composition, and as to sugar, acid, and nitrogen ingredients, while ash analyses of several samples are also given.

The average navel, though the largest of oranges, contained only about 72 per cent of flesh, while the average Mediterranean showed 73 per cent, and the St. Michaels, 81 per cent. The navel was the driest, while the St. Michaels had the largest proportion of juice, the Mediterranean sweet following second, and the Malta blood third. For analyses see *Appendix, Table III.*

The fertilizing ingredients removed from the soil by a crop of oranges is shown for the Californian in comparison with the European fruit, the amount being materially less for the former. Potash is the predominating element, but this is well supplied in most California soils; phosphoric acid, though not very heavily drawn upon, is rather deficient in the soils of the State, and should probably be prominent in any fertilizer used, as also nitrogen, which is largely demanded by this fruit but deficient in the soils of that region. Lime is largely required by the fruit, but is abundant in the soil. The considerable demand of the orange for sulphuric acid suggests the desirability of gypsum as a fertilizer for this as well as for other reasons.

Similar work has been undertaken with the orange at the Florida Station and some results obtained are reported in *B. 17*. An average analysis of fruit of several

varieties from different localities is given (see *Appendix, Table III*) and, based upon this, the composition of a fertilizer which would restore the ingredients removed. It is found that potash, the ingredient most largely demanded, is precisely the one which is relatively deficient in popular orange fertilizers sold in the State, while phosphoric acid, which is abundant in the soils of the State, is supplied by these fertilizers in excess. A calculation of the amounts of the three ingredients in 1,000 fresh oranges is given.

Orange melon (*Cucumis melo* var.) [also known as Vine peach, Garden lemon, Mango melon, Vegetable orange, or Melon apple].—A variety of the muskmelon species, resembling varieties cultivated in Europe, said to be grown quite extensively in the Northwest by Swedes, Norwegians, and Danes, as is also a similar variety known as Queen Anne's Pocket melon.

The fruit is used to make pickles or as a vegetable to be dried or boiled. Descriptions and estimates based upon trial may be found in *Minn. R. 1888, p. 249; N. Y. State R. 1888, p. 127; N. Y. Cornell B. 15; R. I. R. 1890, p. 160.*

Orchard grass.—See *Grasses.*

Oregon Station, Corvallis.—Organized under act of Congress March, 1888, as a department of Oregon State Agricultural College. The staff consists of the president of the college and director, agriculturist, entomologist, chemist, horticulturist, botanist, assistant chemist, and foreman of farm. The principal lines of work are soils, field experiments with field crops, vegetables, and fruits, and entomology. Up to January 1, 1893, the station had published 2 annual reports and 21 bulletins. Revenue in 1892, $15,000.

Osier willows.—See *Willows.*

Oxeye daisy.—See *Weeds.*

Oyster culture.—Studies on oysters, with special reference to the conditions for their propagation, are in progress at the New Jersey Station. Accounts of the observations thus far made are given in *N. J. R. 1888, p. 163, R. 1889, p. 197, R. 1890, p. 249, R. 1891, p. 179.*

Oyster-shell bark louse (*Mytilaspis pomorum*).—An insect introduced from Europe which has spread widely through this country. It is found mostly upon the apple tree, but sometimes infests the pear, plum, and currant. The younger twigs will be seen covered with scales shaped like an oyster shell, usually with the smaller end up. The scales are about a sixth of an inch long and about the color of the bark. Under these scales the louse lives for a considerable portion of its life and deposits its eggs, about a hundred in number. In the spring the minute insects hatch out and crawl about for some time. Finally they attach themselves to the bark by their beaks, secrete a scale over themselves, and live upon the sap of the trees. When very numerous, as they sometimes are, this is a serious drain upon the tree.

Inspect all young trees when planted and scrape or brush off all scales with a stiff brush, and wash with weak lye or strong soapsuds. Brushing off scales in the spring and washing or spraying with strong soda water or kerosene will kill the insects. This must be done after the eggs have hatched. In the South there may be two broods in a season. (*Me. R. 1888, p. 157; N. Mex. B. 3; N. Y. State B. 35, n. ser; Ohio B. Vol. III, 4 and 11.*)

Papaw.—The true papaw or melon-tree (*Carica papaya*) has been tested for introduction in California (*R. 1880, p. 67, R. 1882, p. 107, R. 1885–'86, p. 116, R. 1890, p. 235*). It was found too tender for the greater part of the State, but appeared capable of success in favored localities from San Diego southward. The possession by this tree of the peculiar property of making tough meat tender is attested on the ground of personal trial. "All parts of the plant are pervaded with a peculiar principle (very rich in nitrogen and probably allied to pepsin) having a powerful influence on muscular fiber, causing it to separate" (*Cal. R. 1881–'82, p. 107*).

The papaw of the eastern States (*Asimina triloba*) has been planted at Berkeley (*Cal. R. 1880, p. 67*).

Paris green.—See *Insecticides.*

Parsley (*Carure petroselinum* [*Petroselinum sativum*]).—Tests of varieties are described in *Nebr. B. 6; N. Y. State R. 1883, p. 209, R. 1885, p. 190.* In *N. Y. State R. 1883, p. 209,* the Hamburg variety and one from Norway are particularly noted as having thickened taproots, used in the same manner as celeriac or turnip-rooted celery.

Germination tests of parsley seed are reported in *N. Y. State R. 1883, pp. 69, 85, 208; Vt. R. 1889, p. 107.*

Parsnip (*Peucedanum* [*Pastinaca*] *sativum.*—Variety tests of this vegetable are recorded in *Nebr. B. 12; N. Y. State R. 1883, p. 180, R. 1885, p. 116.* At the New York State Station in 1885 a row of wild parsnips was planted beside the cultivated, and the roots were found to be little inferior in size though much more rough and branching, suggesting that decided improvements may yet be made in the parsnip.

The root system of the parsnip was observed at the same station (*R. 1884, p. 311*) and found to be a deep one. The tap root of one specimen was traced downward 30 inches. Many branches started below the clay line; the fibrous roots in the upper layers of soil were numerous but rather short. An analysis of the parsnip is given in *Mass. State R. 1891, pp. 318, 324* (see *Appendix, Table III*). For a sugar analysis see *Minn. R. 1888, p. 103.*

Germination tests of parsnip seed are recorded in *Me. R. 1888, p. 140, R. 1889, p. 151; Ohio R. 1885, pp. 167, 176; Pa. R. 1889, p. 164; S. C. R. 1888, p. 85; Vt. R. 1889, p. 107.*

Parturient apoplexy.—See *Milk fever.*

Pasturage.—For comparison of soiling and pasturage see *Soiling.*

For effect on the milk of change from barn to pasture see *Milk, effect of food.*

For effect of grain ration for cows at pasture see *Cows.*

Pea (*Pisum* sp., etc.).—See also *Chick pea.* The ordinary pea of the North is *P. sativum,* sometimes distinguished as English pea. In the South the cowpea (*Dolichos sinensis?*) is more largely grown (see *Cowpea*).

Varieties.—Variety tests of English or garden peas are recorded in *Ala. College B. 1, n. ser., B. 7, n. ser.; Ala. Canebrake B. 1, B. 6; Ark. R. 1888, p. 40, R. 1889, p. 98; Colo. R. 1888, p. 122; R. 1889, pp. 33, 94, 120, R. 1890, pp. 45, 186, 189, 211; Fla. B. 14; Ga. B. 11; Ind. B. 18, B. 31, B. 34, B. 38; Kans. R. 1888, p. 256, R. 1889, p. 151; Ky. B. 32, B. 38; La. B. 3, 2d ser.; Me. R. 1888, p. 129, R. 1889, p. 145, R. 1890, p. 103; Md. R. 1889, p. 61; Mich. B. 57, B. 70; Minn. B. 11, R. 1888, p. 240; Mo. B. 13; Nebr. B. 6, B. 12, B. 15; N. Y. State R. 1882, p. 139, R. 1883, p. 196, R. 1884, p. 228, R. 1886, p. 247, R. 1887, p. 330, R. 1888, p. 131, R. 1889, p. 318, R. 1890, p. 293; N. C. B. 74; Ohio R. 1883, p. 137, R. 1884, p. 142, R. 1885, p. 128, R. 1886, p. 174, R. 1887, p. 236; Ore. B. 4, B. 7, B. 15; Pa. B. 10, B. 14, R. 1888, p. 146, R. 1889, p. 174; Tenn. B. Vol. V, 1; Utah B. 3, B. 10; Vt. R. 1890, p. 160.*

In *N. Y. State R. 1884, p. 238,* a classification is made of the varieties tested at that station, of which 98 appeared to be distinct. Three agricultural species are recognized: *Pisum sativum,* the common garden pea, *P. macrocarpon,* the edible-podded pea, and *P. arvense,* the field pea. The varieties are subdivided according to height of vine, color and surface of seeds, and form of pods. The varieties recognized are fully described, synonyms given, and all the names indexed. In *Kans. R. 1889, p. 156,* a descriptive list is given of 99 varieties, classified according to the surface and color of the seeds, earliness, and character of foliage. A variety of table peas from Ceylon is noted in *Cal. B. 95.*

Composition.—An analysis of the seed of garden peas occurs in *Conn. Storrs R. 1890, p. 15* (see *Appendix, Table III*).

Culture.—Notes on the cultivation of peas are given in *Ind. B. 18.*

At the New York State Station in 1883 (*R. p. 204*) the experiment was tried of

planting the earlier and the later ripened peas of the Tom Thumb variety, from which it appeared that the earlier ripened vegetated decidedly better and gave peas fit for use on the average five days sooner. A similar experiment with several varieties in 1884 (*R. p. 231*) showed an average gain of only one day in earliness, while in yield there was an advantage of 18 to 100 pods in favor of the latest ripened seed. Seed from well-filled and poorly-filled pods was also compared. In the case of Culverwell Telegraph variety plants from pods containing one or two seeds did better than those from eight-seeded pods, but were excelled by those from ten-seeded pods. This trial was repeated in 1885 (*R. p. 188*) with a similarly confusing result. With Laction Marvel variety the better filled pods gave the better results.

In *N. Y. State R. 1883, p. 206, R. 1884, p. 236*, and *R. 1885, p. 187*, occur notes upon experiments in cross-fertilizing peas.

In 1884 (*R., p. 234*) and 1885 (*R., p. 188*) tests were made of seeds planted in order as found in the pods, in both cases with conflicting results. In *R. 1884*, a comparative test of ripe and unripe seed is reported. The time of maturity of the crop appeared to be little influenced by the kind of seed.

The same year (*R. 1885, p. 233*) a comparison was made of seed from most and least productive plants of thirteen varieties. On the average the seed from the least productive plants for some reason gave a larger yield than the others. It was noted that in all cases the later maturing plant gave the larger yield.

Planting seed already sprouted was found in 1884 to secure a gain in earliness of about eight days; in 1885 a gain of about three days (*R. 1884, p. 188*).

Germination tests of seed peas are recorded in *Ark. R. 1889, p. 96; Mich. B. 57; N. Y. State R. 1883, pp. 60, 70; Ohio R. 1883, p. 177, R. 1885, p. 170; Ore. B. 2; Pa. R. 1889, p. 164; S. C. R. 1888, p. 82; Vt. R. 1889, p. 108.*

Different distances and depths of planting were also compared at the New York State Station. A distance of 7 inches secured the full development of the plant, but 2½ inches gave a better yield. Shallow planting (up to one-quarter inch) produced more vigorous plants than deep planting.

The rooting habit of the pea was observed at the same station (*R. 1884, p. 305*), and the taproot was traced downward to a depth of 39 inches. The branches were generally little more than a foot long, growing shorter with increase of depth. A striking illustration of the effect of soil on peas is noted in *N. Y. Cornell B. 15*. Experiments with fertilizers on garden peas are recorded in *Ga. B. 14; Mass. Hatch. R. 1888, p. 43*, (effect of fertilizing ingredients on time of maturing); *N. Y. State R. 1884, p. 236.*

FIELD PEAS.—By the term field pea is sometimes meant the Southern cowpea, but more often the field varieties of the English pea. The field pea in the latter sense has been to some extent investigated as a forage and soiling crop, and pea meal has been employed in feeding experiments. The Canada pea is recommended (*N. Y. State R. 1890, p. 357*) as best for forage purposes, and the results of a comparative trial are given in which this variety gave considerably larger yields than garden peas. At the Minnesota Station (*B. 11*) several field varieties, including Canada, were tested. White and blue Canada peas were also sown with oats in different proportions, with results indicating that three bushels of peas should be sown to one of oats, or, where the oats stool largely, to two-thirds of a bushel. The advantage of this crop in rotation with wheat is presented, and it is believed that the peas will pay when machinery is invented for harvesting and threshing them as good as that provided for wheat.

In an effort in Michigan (*B. 68*) to find means of improving Jack-pine plains, field peas after trial were considered to be full of promise. See also *Ark. R. 1890, p. 130, Colo. R. 1889, pp. 94, 125, R. 1890, p. 186; Conn. Storrs R. 1891, p. 10* (with oats).

Experiments with fertilizers on field peas are reported in *Me. R. 1890, p. 79; Minn. R. 1888, p. 143.*

For an analysis of the small pea (*Lathyrus sativus*) planted at the Massachusetts State Station (*R. 1890, pp. 169, 181*), see *Appendix, Table III.*

For root tubercles on peas and their relation to the acquisition of atmospheric nitrogen see *Leguminous plants.*

Pea meal.—The composition and digestibility of meal from Canada peas is given in *Me. R. 1889, p. 66.* For analysis see *Appendix, Tables I and II.* Nearly nine-tenths of the dry matter was found to be digestible. An analysis of pea meal occurs also in *Mass. State R. 1891, p. 319.* Pea meal was also used in feeding pigs at the Maine Station (*R. 1889, p. 87*).

Peanut (*Arachis hypogæa*) (also called Goober, or Ground pea).—A leguminous plant, resembling clover, but peculiar in maturing its fruit underground. After the flowers fall, the stalk bearing the small ovary elongates and curves downward until the ovary is thrust into the ground, where it enlarges and ripens. This habit makes an open porous soil most suitable for the growth of peanuts.

The stations have thus far made only a few experiments with this crop. *Tenn. B. Vol. IV, 2,* contains considerable information regarding the culture and chemical composition of peanuts. It costs about 40 cents per bushel to grow peanuts in Tennessee, and the average price to the producer is about one dollar. The average crop is from 40 to 60 bushels per acre. The soil used is sandy or gravelly clay, with a clay subsoil, and is derived from silicious limestones and sandstones. The land should be warm and well drained. Lime, or marl, must be added, if not already present in the soil in sufficient quantity.

"Two kinds of peanuts are grown in Tennessee, viz, white and red. The white variety is produced in much the larger quantity, as they bring about 25 cents per bushel more than the red. The red nut is so called from the color of the skin of the kernel. The white nut has a skin nearly or quite white, but which darkens with age. The white nut has a more spreading habit of growth than the red, is said to be more prolific, and is later in coming to maturity. The red matures better because earlier, and yields fewer imperfect pods, called 'puffs' or 'pops.'"

The land should be prepared for peanuts early in the spring, and thoroughly pulverized before planting. Planting should be done the last of April or the first of May in checked rows 24 to 32 inches apart. "Two peas, carefully hulled out by hand, so as not to break the inner husk, are dropped at the intersection of the rows and covered about two inches deep." Weeds must be kept out and the soil must be kept loose and fine. "Break the crust as often as it forms with a harrow, and finally with double shovels. Cut out the grass about the hills with a hoe, and 'lay by' after the ovaries are set in the ground, usually about the first of August." Clover, turned under, is an excellent fertilizer for peanuts. Unless used for hay the peanut vines should be returned to the soil. Barnyard manure should be used with care, as it is likely to cause the plants to "run to vine."

"Peanuts are harvested soon after the first frost by running the point of a plow under the vines to cut the roots, and then lifting the vines with the pods out of the soil with a fork. When wilted, stack loosely round a pole 7 feet high, using some sticks to keep them off the ground, and cap off with hay or straw. If stacked in large stacks, or too closely, they will heat." After about four weeks the nuts may be picked off the vines and stored where they will be kept dry and well aired. Before offering the crop for sale it should be screened and sorted.

The Spanish variety has been grown at the North Louisiana Station with excellent results. It has an erect growth and the nuts hang firmly on the plant. It is thus cultivated and harvested without difficulty. The nuts are smaller than those of the common Virginia variety, but are very sweet and abundant. (*La. B. 22, B. 27, B. 8, 2d ser.*)

(See also *Ala. College B. 3, n. ser.; Colo. R. 1890, p. 204; Nebr. B. 19; N. C. B. 65.*)

For composition see *Appendix, Table III.*

Pea tree (*Caragana arborescens*).—"A small tree with acacia-like foliage, desirable at the North for lawn planting. It is pretty in foliage, flower, and when loaded with its scarlet pods in autumn. It also makes a fine stock on which to top-work the dwarf species of the caragana with weeping habit." (*Iowa B. 16.*)

Pea weevil (*Bruchus pisi*).—The adult insect, which greatly resembles the bean weevil, is nearly black with some white spots, the largest somewhat resembling a capital letter T. The eggs are laid on the pods (one for each pea), and the small worm eats its way through the pod and into the pea, where it spends the winter, maturing and coming forth about planting time.

Weevils of peas and beans may be killed by subjecting the peas or beans as soon as gathered to a temperature of 145° F. for an hour. If the peas are placed in a tight box with a little bisulphide of carbon, the weevils will be killed. Keeping the peas in tight boxes or bags for two years, so that none of the weevils escape, will also destroy them. Soaking the seed for twenty-four hours before planting is said to destroy the weevils.

(Colo. B. 6; Kans. B. 19; Ky. B. 40; Mass. Hatch. B. 12; Miss. B. 14; Mo. B. 6; N. C. B. 78; Ohio R. 1888, pp. 131, 163; Ore. B. 5.)

Peach (*Prunus* [*Amygdalus*] *persica*).—The peach has been widely planted at the stations, where its varieties have been tested and the method of its culture and the means of protecting it from cold and from its insect and parasitic enemies have been studied.

VARIETIES.—Tests are reported as follows: *Ala. College B. 11, n. ser., B. 30, n. ser., R. 1888, p. 5; Ala. Canebrake B. 2, R 1888, p. 7; Ark. R. 1888, p. 56; Cal. R. 1882, p. 82, R. 1889, pp. 86, 107, 136, 182, R. 1890, pp. 260, 280, 287, 294, 299; Del. B. 11; Fla. B. 11, B. 14; Ga. B. 11; Ill. B. 21; Ind. B. 10; La. B. 22, B. 26, and B. 3, B. 8, B. 17, 2d ser.; Mass. Hatch B. 4, B. 10, B. 17, R. 1889, p. 31; Mich. B. 55, B. 57, B. 59, B. 67, B. 80; Miss. R. 1889, p. 38; Mo. B. 10; N. Mex. B. 2; N. Y. State R. 1882, p. 144, R. 1884, p. 21, R. 1888, pp. 93, 98, R. 1889, p. 340, R. 1890, p. 332, R. 1891, p. 493; N. C. B. 72; R. I. B. 7; Tenn. R. 1888, p. 12, B. Vol. III, 5, B. Vol. V, 1; Tex. B. 8, B. 16, R. 1889, p. 48, R. 1890, p. 50, R. 1891, p. 169; Va. B. 2.*

COMPOSITION.—Partial analyses of peaches are given in *Mass. R. 1889, p. 302* (also in compilations in *R. 1890, pp. 301, 305, R. 1891, p. 327*) and in *Cal. B. 97*. See *Appendix, Table III.*

Two physical analyses given in *Cal. B. 97* show an average percentage of 93.8 of flesh and 6.2 of stones.

Analyses of healthy and diseased peach wood are given in *Conn. State R. 1884, p. 93.*

CULTURE.—General notes on peach culture for Florida may be found in *Fla. B. 4, B. 14.* The ends to be secured in pruning peach trees are defined in *Ala. College B. 11, n. ser.; N. Y. State R. 1889, p. 338.* The tenderness of peach buds in the presence of severe cold has led to investigation with a view to their protection. At the Massachusetts Hatch Station (*B. 10, B. 17*) many buds of each of several varieties were examined weekly through two winters to learn in what parts of the season, and in what numbers in the different parts, the buds are destroyed. In 1892 the buds were largely killed before the middle of December, and generally before the temperature had reached zero or more than a few degrees below. The number of buds per hundred killed up to March 1 is shown for three years. Experiments were made at the station for many years to find some means of protection. Nothing succeeded in saving the buds with the trees in an upright position, but it was found that the tree could be laid down and lightly covered in winter in such a way as to save a large percentage of the buds and to leave the tree in a thrifty condition when restored to the upright.

At the Kansas Station, likewise, after an unsatisfactory trial of covering in an erect position the trees were bent down and covered for the winter with hay, etc., with small expense and decidedly gratifying results. In this method the roots are are cut on the north and the south side so as to secure a lateral development, and the side roots are slightly twisted in bending down the top. A very similar experiment was made at the Missouri Station (*B. 16*). Here some of the trees were so covered as to admit of opening, and thermometrical observations were taken. It was found that the inside temperature was higher in cold weather and lower in warm

weather than the outside. No perceptible injury was done to the trees or crop by laying down.

At the New Jersey Station during the latter half of the winter of 1889–'90, in which unusual warmth was followed by severe cold, microscopic examinations of peach buds were made, as reported with graphic illustrations in *R. 1890, p. 327*. The same season information was gathered by circular inquiry respecting the conditions of soil, situation, etc., under which the buds are best preserved (*R. 1890, p. 323*).

MANURING.—Experiments with fertilizers upon peach trees are reported in *Del. B. 11; Md. R. 1890, p. 114; Miss. R. 1888, p. 47; N. J. R. 1889, p. 133, R. 1890, p. 153, R. 1891, p. 133*. Notes on special fertilizers for peach trees are given in *N. J. R. 1883, p. 94*, special reference being made to Goessmann's and Penhallow's experiments with muriate of potash as a cure for yellows.

Peach aphis.—See *Plant lice.*

Peach curl (*Taphrina deformans.*).—A fungous disease often seriously attacking the leaves and young branches of peach, plum, and cherry trees. Its presence is manifest at the first appearance of the leaves, and as they grow in size they become curled and deformed. The treatment recommended is the same as for black knot of plums and cherries, *N. Y. State B. 54*. (See *Plum, black knot.*)

Peach rust (*Puccinia pruni-spinosæ*).—A fungous disease which attacks peach and plum trees causing their leaves to fall very early in the season. The presence of the disease is indicated early in July by spots of yellowish color upon the leaves, followed by a dark brown color in the case of the plum. These spots increase in size until the whole leaf is killed. The fungus spreads rapidly by means of multitudinous spores. Early and repeated spraying with Bordeaux mixture is advised. Any branches showing traces of the disease should be cut away and burned. (*Tex. R. 1888, p. 38.*)

Peach, spotting (*Cladosporium carpophilum*).—A fungous disease attacking the fruit, on which it may be readily seen in small patches of an eighth of an inch in diameter or larger. The fungus is of an olive-brown color, but its early presence is concealed by the down of the peach. Its filaments do not enter the peach, but draw their nourishment through the skin. By increased growth several of these spots may coalesce, forming a conspicuous dark-colored or often black patch. This injures the fruit by causing a discoloration of the surface, and by preventing its full growth. It is said that the disease hastens decay, and that affected fruit will not stand transportation.

The use of sprays of potassium sulphide, 1 ounce to 4 gallons of water, or copper carbonate solutions, is recommended as a preventive measure. (*Ind. B. 19.*)

Peach-tree borer (*Sannina exitiosa*).—An insect infesting the peach, apricot, plum, and cherry. The adult is a slender bluish wasp-like insect which may be observed flying about the trees in the early summer. The eggs are deposited near the ground, and, upon hatching, the young grubs gnaw their way through the bark into the sap wood. Their presence will generally be indicated by a gummy exudation from holes through the bark. The borer lives a year in the tree and comes forth a flying moth. The worm is small, and whitish, with reddish-brown head.

Various remedies are suggested. Digging the larvæ out with a knife or removing the gum and inserting a flexible wire will destroy them. They may be prevented, at least partly, by whitewashing or painting the tree for some distance from the root and then hilling up the earth for several inches. Paris green should be added to the paint or wash. Tying one end of newspapers (or long straw) about the tree some distance from the ground, while the other end is extended below ground and covered with earth, will keep the moths away from their usual places for depositing their eggs. In this case the eggs may be laid at the top of the paper or in the crotch of the trees, where they may be found in the fall.

(*Ark. R. 1889, p. 145; Miss. B. 14; N. J. R. 1889, p. 299, R. 1890, p. 497; N. Mex. B. 3; N. Y. State B. 25; N. C. B. 78; Ore. B. 5; W. Va. R. 1890, p. 157.*)

Peach yellows.—A peculiar and obscure disease which is making considerable trouble in certain parts of the country. It attacks trees about the time they are coming to the age of most prolific bearing to such an extent that in certain portions of the peach-growing regions healthy old trees are unknown. The symptoms of the disease are: Yellowish-green color of leaves; small leaves tinged with red; the new shoots small, wiry, and clustered, especially when growing upon the trunk or larger branches; fruit ripens prematurely, is highly colored, and insipid or bitter to the taste. The sickly yellowish-green foliage may be due to injury or lack of nourishment, but when coupled with the other characters given the presence of the "yellows" can be considered as certain. It was thought that the use of fertilizers would prevent the attacks by securing a more healthy and vigorous growth, but after extensive field tests this treatment is believed to have no lasting effect. The only sure way is to dig out and burn every tree as soon as it is seen to be affected. Young trees may be planted, and thus the orchard may be renewed. This plan has been followed in Michigan, where, between 1870 and 1880, the disease was very bad. Now hardly a case of "yellows" can be found in many of the peach regions. Constant attention and prompt action have proved successful, in this case, at least. (*Conn. State B. 111; Mass. Hatch B. 8; N. Y. Cornell B. 25.*)

Pear (*Pyrus communis*).—The study of the pear at the stations has related chiefly to its varieties and its parasitic and other enemies. Tests of varieties are reported as follows: *Ala. College B. 30, R. 1888, p. 5; Ala. Canebrake R. 1888, p. 7; Ark. B. 17, R. 1888, p. 56; Cal. R. 1882, p. 81, 83, R. 1889, pp. 86, 108, 136, 184, 188, R. 1890, pp. 269, 279, 288, 295, 298; Colo. R. 1889, p. 117, R. 1890, pp. 31, 198, 213; Fla. B. 14; Ga. B. 11; Ind. B. 10; Iowa B. 3; La. B. 3, B. 8, B. 16, 2d ser.; Me. R. 1889, p. 255, R. 1890, p. 140, R. 1891, p. 94; Mich. B. 55, B. 59, B. 67, B. 80; Minn. R. 1888, pp. 199, 283, R. 1890, pp. 34, 38; Miss. R. 1889, p. 38; Mo. B. 10; Nev. R. 1890, p. 30; N. Mex. B. 2; N. Y. State R. 1882, p. 144, R. 1883, p. 20, R. 1888, pp. 91, 98; N. C. B. 72; Ohio R. 1882, p. 58, R. 1883, p. 146; Pa. B. 18, R. 1888, p. 161; R. I. B. 7; Tenn. B. vol. III, 5, B. vol. V, 1, R. 1888, p. 12; Tex. R. 1889, p. 48, R. 1890, p. 50, R. 1891, p. 169; Vt. R. 1888, p. 119, R. 1889, p. 121.*

Iowa B. 3 contains an account of the introduction of Russian varieties by that station with descriptions of several that seemed promising; also notes upon some Chinese varieties of which two sorts of snow pear seemed hardy, and had leaves which were handsome and always perfect. In *Colo. R. 1888* is given a calendar embodying observations for two seasons upon the time of leafing and maturing leaves for 32 varieties of pears, with descriptive notes. The investigation had reference to the hardiness of varieties in the climate of that State.

Sugar analyses of Bartlett pears at four stages of maturity are given in *Mass. R. 1889, p. 302, R. 1890, p. 301, R. 1891, p. 327.* (See *Appendix, Table III.*) A calculation of the fertilizing material removed by a crop of pears is given in *Cal. B. 88.*

In *Tex. B. 9* is published an extended discussion of pear stocks, illustrated by figures. The main question considered is, Which is the best stock for the Le Conte and Keiffer pear trees, the Oriental (*i. e.*, the Le Conte or Keiffer on its own roots) or the French pear seedling? The investigations of the writer developed the facts that where these pears were grafted on the French stock, if set deep enough, they put forth roots of their own and threw off the French stock if possible; that when set shallow the stock outgrew the scion, making an ugly enlargement, and sent out excrescences from the top; and that grafted trees forced to grow only on French stocks were far less vigorous and less uniform than those on their own roots. Of numerous correspondents of the station only three recommended the use of the French stock for these pears, while many stated that they believed the Le Conte to be the best stock for European pears.

At the Maryland Station (*R. 1891, p. 422*) by making use of a hotbed to start the sap, Japan seedling pear stocks were successfully budded about the middle of April. They made good growth in the nursery during the summer and were ready to trans-

plant to the orchard in the fall. "This method is practicable on a large scale, and it may be that a large and more convenient incubator can be devised to start the sap enough so the bark will run, and in which to place stocks when budded to make them take."

Pear blight (*Micrococcus amylororus*).—A disease of bacterial origin which attacks pears and apples alike. The leaves and young shoots are the parts affected. The leaves turn yellow and fall off, the young twigs shrivel up and die. If not checked soon, the whole tree dies. The usual sprays seem to have no effect upon this disease, and about the only effectual means of treatment is to cut away the diseased parts and burn them. The branches should be cut back about a foot from the lowest indication of disease and the frequent dipping of the knife in carbolic acid is recommended as an extra precaution during the pruning.

(*Colo. R. 1888, p. 64; Mo. B. 16; N. Y. State B. 92, B. 2, n. ser.; Vt. R. 1890, p. 142.*)

Pear leaf blight (*Entomosporium maculatum*).—A fungous disease, characterized by the discoloration and premature dropping of the leaves, and the spotting and cracking of the fruit. It attacks the quince as well as the pear. The disease first shows itself in the form of small red dots upon the leaves. In their mature form the spots are larger and more or less circular, with a light colored center, surrounded by a slightly raised dark brown border. As these spots increase they often coalesce, involving the whole leaf; at other times the leaf soon turns yellow, and, in either case, drops. The tissue of the leaf between the spots turns brown and the leaf falls. Not uncommonly the young twigs are attacked, sometimes so seriously as to kill the young growth. The infection of the fruit is much the same as on the leaves. The fruit is covered with small, red, speck-like pimples, which increase and coalesce, giving it a very blotched appearance. It often causes the fruit to crack, spoiling its appearance and making it more liable to rot. This disease may be prevented in great measure by spraying the trees with either ammoniacal carbonate of copper, Bordeaux mixture, modified eau celeste, or precipitated carbonate of copper. The first application should be when the leaves are about half grown, and two or three more applications should be made at intervals of two or three weeks. This need cost but a few cents per tree, the Bordeaux mixture being a little more expensive than the other fungicides. (*Conn. State B. 111, R. 1890, p. 99, R. 1891, p. 150; Del. B. 13.*)

Pear scab (*Fusicladium pyrinum*).—This disease is very similar to apple scab, and requires the same preventive treatment (see *Apple scab*). It causes brownish or black scab-like spots on the leaves and fruit, causing the latter to become distorted.

Pear-tree borer (*Sesia pyri*).—The moth of this species is similar to the peach-tree borer and is easily mistaken for a small wasp. It measures about half an inch across the wings. The eggs are deposited upon the bark of the trunk or lower limbs, and when hatched the grub, a small white worm, eats its way into the sapwood, where it remains for about a year. The presence of grubs is indicated by black wart-like swellings. Often several grubs are found in one knot. Dig them out with a knife during the winter or brush kerosene over the swellings. (*Miss. R. 1891, p. 35.*)

Pear-tree slug.—See *Cherry slug.*

Peat.—Origin, formation.—This term is applied to any bog earth of vegetable origin, and includes not only the true peats, but bog mud and marsh mud, as well as the substance termed muck in some localities, the latter being simply impure or unripe peats.

Peat is a result of the partial decomposition of successive growths of plants in low places containing stagnant water. In temperate or cold regions moorlands and small shallow depressions filled with impure peat are widely distributed, but deep bogs are rare (Johnson); in warmer climates, however, peat or muck accumulates as a rule in larger beds or bogs. The heavy rains of these regions sweep down the

decaying vegetable matter from the higher lands into the bogs, thus enormously increasing the accumulation of such débris, and forming immense muck beds (*Fla. B. 7*).

COMPOSITION.—As can be readily judged from its origin and formation, peat is composed largely of organic matter containing a considerable percentage of nitrogen, and a small proportion of mineral matter. Its composition, however, is variable. Analyses of eight samples at the Florida Station (*B. 14*) gave the following results:

Percentage composition of muck.

	Maximum.	Minimum.	Average.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	89.00	11.00	49.00
Organic matter	68.00	11.00	30.00
Ash (including sand and dirt)	69.00	0.30	20.00
Nitrogen	2.88	0.44	1.11
Potash	0.77	0.004	0.14
Phosphoric acid	0.24	0.01	0.10
Insoluble matter	56.00	0.13	17.00

Analyses of thirty samples of peat by Prof. Johnson showed a proportion of nitrogen varying from 0.4 to 2.9—average 1.5.

Considered as a fertilizer, therefore, peat is richer in nitrogen and poorer in potash and phosporic acid than barnyard manure. (For average composition of peat, muck, and barnyard manure, see *Appendix, Table IV.*)

In peat, freshly dug, the nitrogen is largely in an inert and unavailable form. There is also a considerable amount of vegetable acids and iron salts, particularly the sulphide, which render the material unfit for immediate application to the soil. Weathering or composting with proper materials is necessary to render the nitrogen available and to dissipate the deleterious compounds present.

The Florida Station (*B. 14*), after an extensive study of the muck deposits of that State, lays down the following basis for judging the value of this material: "Three things should be taken into account: (1) the quantity of organic matter (the greater the better the muck, other things being equal); (2) the kind of plants from which the muck has been formed (muck from succulent weeds, grass, and mosses would likely contain more nitrogen than that from woody and fibrous substances); (3) the degree of decomposition (except, perhaps, for purposes of mulching, the more disintegrated and decayed a muck the better, other things being equal)."

USES.—Peat is especially valuable for use in stables. It readily absorbs the liquid excrement and prevents loss of ammonia. Prof. Johnson has shown that swamp muck may absorb 1.3 per cent of ammonia, and that it "can absorb and retain nitrogen from manures in some other form than that of ammonia" (Storer).

Peat is most advantageously utilized in composts with wood ashes, manure, lime, etc. Certain kinds of peat composted at the rate of two or three loads of peat to one of fresh stable manure will yield a product as efficient, load for load, as pure stable manure (Storer). A plan of composting given by Storer is as follows: Lay down a bed of peat 6 or 8 feet wide and 1 foot thick, cover with a somewhat thinner layer of manure, follow with another layer of peat, and so on until the heap is 3 or 4 feet high. The heap should be turned as fermentation progresses.

The alkalies, potash, soda, ammonia, and lime, and their carbonates promote fermentation in peat and hasten its disintegration. This fact is often taken advantage of in composting. Prof. Johnson gives the following directions for making alkali composts: "With regard to the proportions to be used, no very definite rules can be laid down; but we can safely follow those who have had experience in the matter. Thus, to a

cord of muck, which is about 100 bushels, may be added, of unleached wood ashes 12 bushels, or of leached wood ashes 20 bushels, or of peat ashes 20 bushels, or of marl or gas lime 20 bushels. Ten bushels of quicklime, slaked with water or salt brine previous to use, is enough for a cord of muck.

"Instead of using the above-mentioned substances singly, any or all of them may be employed together.

"The muck should be as fine and free from lumps as possible, and must be intimately mixed with the other ingredients by shoveling. The mass is then thrown up into a compact heap, which may be 4 feet high.

"When the heap is formed it is well to pour on as much water as the mass will absorb (this may be omitted if the muck is already quite moist), and, finally, the whole is covered over with a few inches of pure muck, so as to retain moisture and heat.

"If the heap is put up in the spring, it may stand undisturbed for one or two months, when it is well to shovel it over and mix thoroughly. It should then be built up again, covered with fresh muck, and allowed to stand as before until thoroughly decomposed.

"In all cases five or six months of summer weather is a sufficient time to fit these composts for application to the soil."

Composting peat with lime slaked in brine has long been practiced as an effective means of reducing this substance to a desirable form for application as a fertilizer. The following formula and directions are given by Sempers: *

Peat or muck	cords	50
Caustic lime	bushels	100
Common salt	do	17

Make a brine of the salt, slake the lime in it, and spread immediately over the peat, which should be laid down in layers about 6 inches thick. The heap is commonly built from 4 to 5 feet high and of any convenient length and width. Fork over at intervals.

Finely ground carbonate of lime or limestone has been employed in peat composts with advantage. It destroys hurtful iron salts and promotes nitrification and fermentation.

The composting of muck with finely ground low-grade rock phosphate containing a considerable percentage of carbonate of lime has been recommended as likely to give good results (*Fla. B. 14*), since not only is disintegration of the peat secured, but an element, phosphoric acid, is added which is deficient in the crude material, The fermentation of the peat also renders the insoluble phosphate, to a considerable extent, available.

Composts of peat with guano, droppings of fowls, fish, etc., have been used with advantage.

Since peat is an incomplete fertilizer, being rich in nitrogen and poor in potash and phosphoric acid, it is desirable to compost so as to increase the latter elements of plant food. Formulas containing stable manure, kainit, acid phosphate, cotton seed, and ashes, which secure this result, are given in *Fla. B. 7*. (See also *Composts.*)

(*Conn. State R. 1880, p. 58, R. 1882, p. 63, R. 1889, p. 115; Fla. B. 7, B. 13, B. 14; Me. R. 1888, p. 61; Mass. State R. 1891, p. 292, 311; N. H. R. 1889, p. 70; N. Y. State R. 1889, p. 56, 256; N. C. R. 1888, p. 53; R. I. B. 11; S. C. R. 1888, p. 140; Tex. B. 13; Vt. R. 1888, p. 66, R. 1889, p. 36, R. 1890, p. 30.*)

Pecan (*Hicoria pecan* [*Carya olivæformis*]).—A valuable nut tree of the hickory genus, native in bottom lands from Iowa and Illinois southward. It has been planted for trial at several stations. (*Cal. R. 1888–'89, pp. 87, 110, 138, 196; Fla. B. 1;*

* Manures: How to Make Them and How to Use Them, p. 68.

Mich. B. 55, B. 67, B. 80; N. Mex. B. 4.) One peculiar form, the "paper-shell" pecan of Texas, is noted.

These trees seemed to suffer somewhat in the hotter and drier parts of California; they had lived without protection, so far as the test had gone, at the Michigan South Haven Substation. In Florida, where they are also native, they were found to do well when transplanted from the woods or grown from the seed.

Pennsylvania Station, State College.—Organized under act of Congress June 30, 1887, as a department of Pennsylvania State College. The staff consists of the president of the college, director, vice-director and chemist, botanist, horticulturist, agriculturist, superintendent of farm, four assistant chemists, assistant agriculturist, gardener, and clerk and stenographer. The principal lines of work are chemistry; analyis of fertilizers; field experiments with fertilizers, field crops, vegetables, and fruits; composition of feeding stuffs; feeding experiments; and dairying. Up to January 1, 1893, the station had published 4 annual reports and 21 bulletins. Revenue in 1892, $23,000.

Pepino (*Solanum muricatum*).—An illustrated account of this plant and its fruit, recently appearing in seedsmen's catalogues as a novelty, is given in *N. Y. Cornell B. 37.* It was first described as growing in Peru, but is also known everywhere in the highlands of Central America. It is a strong growing herb or half shrub, with fruit the size of a large egg, egg-shaped but decidedly pointed, of a warm yellow color, streaked and veined with purple. It seldom produces seed; its pulp and skin are like those of a Bartlett pear; its taste is more like that of a muskmelon, but with a peculiar delicious acid flavor, which, however, does not develop under great heat.

While the plant does not require much heat, great difficulty has been found in making it set fruit in the North. It has been grown with some success in California and Florida. The botanical history of the plant is given in the bulletin referred to, and information based on station experience and upon authority, largely that of Mr. Eisen of California. The station's judgment is:

"The pepino is an unusually interesting plant, and if it could be made to set fruit more freely in the North, it would be an acquisition for the kitchen garden and for market. It is a good ornamental plant. Altogether, it is deserving of a wider reputation."

Peppers (*Capsicum annuum*).—Tests of varieties are recorded in *Colo. R. 1888, p. 136; R. 1889; pp. 102, 120; R. 1890, p. 47; Md. R. 1889, p. 62; Mich. B. 70; Nebr. B. 6; N. Y. State R. 1882, p. 137, R. 1883, p. 192, R. 1884, p. 221, R. 1885, p. 178, R. 1886, p. 244.* In *N. Y. State R. 1886*, about 49 nominal varieties and duplicates from different seedsmen are tabulated and synonyms pointed out. At the New York Cornell Station peppers were used with other plants in experiments in herbaceous grafting. Peppers were found to unite with tomatoes and with eggplants, and also grew on alkekengi.

Germination tests of the seed of peppers are on record in *N. Y. State R. 1883, pp. 61, 70; Ohio R. 1884, p. 200, R. 1885, pp. 167, 176; Ore. B. 2; S. C. R. 1888, p. 77; Vt. R. 1889, p. 108.*

Pepper tree (*Schinus molle*).—A member of the sumach family, introduced into California from Peru as an ornamental tree. It grows rapidly in dry soil, and in the southern part of the State has attained large dimensions. (*Cal. R. 1888–'89, p. 49.*)

Persimmon (*Diospyros* spp.).—The Japanese persimmon or kaki (*Diospyros kaki*) has been planted at several stations southward. The native persimmon (*D. virginiana*) has been planted at the Rhode Island station, being rarely found wild in that State. (*Cal. R. 1880, p. 67, R. 1888–'89, pp. 87, 110, 186; Fla. B. 14; La. B. 22,* and *B. 3, B. 8, 2d ser.; N. Mex. B. 2; R. I. B. 7; Tex. B. 8; Va. B. 2.*)

About fifteen varieties have been introduced, but the station lists generally number ten or less.

A partial analysis of the fruit is given in *Cal. Sup. R. 1878–'79, p. 61.* A mechan-

ical analysis showed pulp 88.32 per cent, seeds 1.03, skins 10.65. The water in the pulp formed 82.58 per cent; the total ash of the dried fruit was 2.023 per cent.

Brief reports on the poor success and the wants of the persimmon in the region of the Berkeley station may be found in *Cal. R. 1880, p. 67.* The necessity of deep culture on account of the long taproot is indicated. The fruit seemed destined to be of considerable importance to California. In *Fla. B. 14* the more extended culture of this fruit is advocated, and some notes are made on its merits and management. The native persimmon is the stock used.

The Italian persimmon (*D. lotus*) is noted in *Cal. R. 1882, p. 102.* It is said to do exceedingly well in the State, to be quite ornamental, and to have an advantage as a grafting stock for the Japanese persimmon over the American tree, on account of a far better root system.

Phosphates.—Although the beneficial effect of phosphatic manures had been known from early times it was not until the announcement of Liebig's theory of plant nutrition in 1840 that the true function and value of phosphoric acid as a plant food began to be appreciated. His suggestion at this time that the phosphate of lime of bones (hitherto considered worthless) could be converted into a valuable fertilizer by treatment with sulphuric acid and the carrying of this suggestion into practical effect by Sir John Lawes brought into being the chemical fertilizer and phosphate industry, which has now attained enormous proportions. The increased demand for phosphates to supply these manufactories stimulated an active search for deposits of mineral phosphates to supplement the supply of bone which had heretofore been used almost exclusively. For a time the guano deposits of South America and the West Indies supplied this demand, but these beds were practically exhausted in 1870, and other sources of supply were sought with the result that there have been developed and worked the coprolitic phosphates of England, coprolitic phosphates and those commercially known as Bordeaux phosphates in France, the Estramadura beds of Spain, the Krageroe and Oedegärden deposits of Norway, the Nassau beds of Germany, commercially known as Lahn phosphates, the Navassa, Sombrero, Curaçoa, and Aruba phosphates of the West Indies, the apatite deposits of Canada, and finally the North Carolina, South Carolina, and Florida deposits of the United States. The growth and extent of the phosphate mining industry is indicated by the following table:

*The world's production of raw phosphates in 1880 and 1890.**

	1880.	1890.
	Tons.	*Tons.*
England (coprolites)	30,000	20,000
France (Somme deposits	....	170,000
France (other deposits)	125,000	200,000
Belgium (Mons district)	15,000	150,000
Belgium (Liége district)	....	50,000
Germany (Lahn phosphates)	25,000	30,000
Norway	5,000	10,000
Canada (apatite)	7,500	26,000
South Carolina (land deposits)	125,000	300,000
South Carolina (river deposits)	62,000	237,000
Florida	....	40,000
Spain (Estramadura)	40,000	....
West India Islands	35,000	50,000
Other sources	30,000	20,000
Total	500,000	1,303,000

*From Millar's Florida, South Carolina, and Canadian Phosphates, pp. 19, 20.

The principal sources of phosphoric acid at the present time in the United States are bones, guanos, marls, the phosphate deposits of North Carolina, South Carolina, and Florida, the apatites of Canada, and basic slag (commercially known as Thomas slag) from iron furnaces.

Basic slag.—This is a by-product from the manufacture of steel by the basic or Thomas process, hence the names basic slag and Thomas slag, under which it is sold.

In this process phosphorus is eliminated from pig iron by means of a basic (rich in lime) lining to the Bessemer converters. The slag produced is rich in lime and contains from 14 to 20 per cent of phosphoric acid. The annual production in England is about 150,000 tons, in Germany 225,000. Owing to its high percentage of iron and aluminum it can not be economically converted into superphosphate, but is put on the market in the form of a fine powder. It is prepared for the market in the United States to a limited extent and sold under the name of Odorless phosphate. (*N. J. R. 1889, p. 39.*)

South Carolina phosphates.—The discovery of the marl beds in New Jersey in the early part of the present century and the beneficial results obtained from the use of the marls led to the search for similar deposits in other parts of the country. In 1842 Edmund Ruffin, in making an agricultural and geological survey of South Carolina, located beds of calcareous marl in that State. Analysis showed these marls to contain a high percentage of carbonate of lime, and the marling of lands was actively engaged in. The unusually beneficial effect resulting from the use of certain of these marls found in the vicinity of Charleston, South Carolina, led Dr. C. U. Shepard in 1845 to examine them with a view to ascertaining the cause of their remarkable fertility. His analysis showed the presence of a considerable percentage of phosphate of lime (as high as 9.2 per cent), and to this substance he ascribed their fertilizing value. Specimens of nodules had been collected by Prof. F. S. Holmes, in 1837, scattered over the surface of the rice fields of the Ashley River. These were pronounced of little value by both Mr. Ruffin and Prof. Toumey, although the latter had found in some specimens as high as 15 to 16 per cent of phosphate of lime. Similar nodules were afterwards observed in marl beds by Prof. Holmes and others. In 1859 Dr. C. U. Shepard called attention to the deposits of these nodules, explaining the true cause of their fertilizing value, and predicting rapid development in the phosphate industry in South Carolina. It was not, however, until 1867 that actual mining commenced.

"The deposits occur in a strip of country varying in breadth from 10 to 20 miles, commencing at Broad River in the southeast, and running 60 miles along the coast in a northeasterly direction as far as the head waters of the Wando River." (Millar.) Dr. Shepard, jr., in 1880 estimated the area underlaid by phosphates as 240,000 acres, only 10,000 of which could be profitably worked. Since then new deposits have been discovered and improvements in mining methods made which have gradually increased the available area. The phosphate occurs in the form of irregular nodules, varying in size from the smallest particles to pieces weighing several pounds and occasionally as high as a ton. The average nodule, however, varies from pea to potato size. These are scattered through a stratum varying in thickness from a few inches to 5 feet, and bearing an overburden which varies in depth from a few inches to 60 feet. Two classes of nodules are mined, the hard, bluish-black river nodules and the light-brown porous nodules underlying the land and usually immediately overlying marl beds. The average composition from many hundred analyses by Dr. Shepard, jr., is as follows:

Composition of South Carolina phosphates.

	Per cent.
Phosphoric acid	25 to 28
(Equivalent to 55–61 per cent tribasic phosphate of lime.)	
Carbonic acid	2.5 5
(Equivalent to 5–11 per cent carbonate of lime.)	

	Per cent.	
Sulphuric acid	0.5 to	2
Lime	35	42
Magnesia	traces..	2
Alumina	traces..	2
Sesqui-oxide of iron	1	4
Fluoride	1	2
Sand and silica	4	12
Organic matter and combined water	2	6

The average phosphates shipped from the mines show 56 to 62 per cent of phosphate of lime, 5 to 10 per cent of carbonate of lime, and 1 to 2 per cent of oxide of iron and alumina. Correct estimates as to the extent of these deposits of course can not be formed, but according to Millar it may be safely assumed that there is a sufficient amount of land rock alone to supply the demands of the market for the next fifty years. In 1891 twenty-two companies, representing a capital of $3,000,000 were engaged in mining South Carolina phosphates.

Florida phosphates.—In 1881 J. Francis Le Baron, who was making a Government survey, discovered bars and beds of phosphates in Peace River, Florida. He appreciated the extent and true value of the phosphates of South Florida and subsequently took steps to reap the advantages of his discovery, but his negotiations for acquiring land failed, and it was not until the spring of 1888 that actual mining operations were commenced under the direction of the Arcadia Phosphate Company.

"The phosphate deposits occur on the western side of the peninsula, and to use very wide and general terms may be said to be found in every county from Tallahassee to Charlotte harbor (Millar.) The supply of phosphate is considered practically inexhaustible.

The beds may be conveniently divided into two classes, the pebble deposits of south Florida and the rock deposits of north Florida. The former occur in beds varying in thickness from a few inches to 30 feet or more with an overburden averaging about 8 feet, and consists of pebbles varying in size from the smallest particles up to potato size (the average being between one thirty-second of an inch and 1½ inches in diameter), buried in a plastic argillaceous matrix containing, according to Wyatt, about 15 per cent of phosphoric acid and 13 per cent of oxide of iron and alumina. Two classes of pebble are mined, land pebble and that found in the rivers. Both are undoubtedly of the same origin, but the composition of the river pebble has been altered somewhat since its removal from the original bed. The composition of each class as shipped from the mines may be seen from the following averages calculated from a large number of analyses by Voelcker, Dyer, Shepard, Teschmacher, and Cannon and Newton.

Composition of Florida land and river pebble phosphate.

	Land pebble.	River pebble.
	Per cent.	*Per cent.*
Phosphoric acid	33.16	28.26
Equal to tribasic phosphate of lime	72.40	61.69
Oxide of iron and alumina	1.60	1.96

From twenty to twenty-five companies, representing capital varying in different cases from $50,000 to $1,000,000, are engaged in mining pebble phosphate.

Rock deposits have been discovered in all of the northern counties of Florida from Tallahassee to a few miles north of Port Tampa. The phosphates occur in a series of pockets and in drifts covered by an overburden of a thickness varying from a few inches to many feet, and consists of rough and jagged pieces of phosphate rock, soft

phosphate, and phosphate bowlders, which are rough, irregular masses of rock weighing from a few pounds to several tons. Analyses by Dr. Francis Wyatt of several hundred carefully selected samples of this phosphate gave the following results:

Composition of Florida rock phosphate.

[Bowlder phosphate—clean high-grade rock. Bowlders and débris—unselected phosphatic material. Soft white—soft white phosphate in which no bowlders are found. Unselected—everything that was thrown up from the pits, phosphates and inert and waste matter.]

	Lime.	Phosphoric acid.	Oxide of iron and alumina.	Insoluble siliceous.	Carbonic acid.	Fluoride.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Bowlders (137 analyses)	42.10	34.15	6.32	5.20	1.80	1.70
Bowlders very carefully selected (86 analyses)	45.90	36.10	4.80	4.95	1.70	1.57
Bowlders and débris (160 analyses)	38.20	29.70	9.42	13.25	2.10	1.49
Soft white (97 analyses)	41.70	32.50	8.70	5.20	4.80	1.15
Unselected, total outcome (76 analyses)	27.40	13.80	18.65	31.00	3.16	0.37

In general it may be said that this class as shipped from the mines contains from 75 to 80 per cent of phosphate of lime as compared with 60 to 65 in the river pebble and 65 to 70 per cent in the land pebble of South Florida.

In addition to the above deposits beds of gravel rock have recently been developed in Alachua, Levy, and Marion Counties, and are being worked to some extent. These phosphates contain from 75 to 80 per cent of phosphate of lime, but average between 2 and 3 per cent of oxide of iron and alumina, and require thorough washing and cleaning before being put on the market in order to insure their coming within the guarantied limits of 3 per cent of oxide of iron or alumina under which these phosphates are sold.

Seventeen companies, representing capital ranging from $30,000 to $5,000,000, were engaged in mining the rock and gravel phosphates of North Florida in 1891. The total product of phosphate in Florida in 1891 was something over 200,000 tons.

North Carolina phosphates.—Coprolite phosphates (so-called) and animal remains had been observed in the marl beds of North Carolina as early as 1852, but it was not until 1883 that the existence of extensive phosphate deposits similar to those of South Carolina was established by investigations under the auspices of the North Carolina Station (*R. 1884, p. 44*). These explorations covered 125 acres which were estimated to be capable of yielding 50,800 tons of phosphate containing percentages of phosphate of lime ranging from 28 to 57 per cent. The area has since been considerably extended and deposits in Pender and New Hanover counties have been worked to some extent (*R. 1889, p. 43*), but in view of the greater extent and superior quality of the more accessible beds of South Carolina and Florida it is not probable that these phosphates will be worked except for home consumption for many years to come.

Canada apatite.—Although not strictly within the scope of this article, a brief reference to the apatite deposits of Canada seems desirable in this connection. These deposits are very different from those we have just been discussing. They occur in the oldest rock formation (the Laurentian) of the earth's crust as a "series of pockets or beds of various sizes connected with stringers or leads of phosphate." Consequently the yield of the beds is very variable. Occasionally enormous pockets are found which yield richly for some time and suddenly the vein may dwindle until it is worthless for mining purposes. The apatite occurs in the form of very hard bluish-green crystals. Analyses of selected samples by Dr. C. Hoffman show these phosphates to contain from 85 to 90 per cent of phosphate of lime and less than 1 per

cent of oxide of iron and alumina. The total shipment of Canada phosphate in 1891 was 16,000 tons, of which 2,000 tons came to the United States.

TREATMENT OF RAW PHOSPHATE.—The principal use of raw phosphate is in the manufacture of superphosphate or acid phosphate; that is, the conversion of the insoluble phosphate of lime (tri-calcium phosphate) into a soluble form (mono-calcium phosphate) by treatment with sulphuric acid. Since impurities in the raw phosphate, especially any considerable percentage of oxide of iron and alumina (3 per cent or more), interferes with the success of this operation, causing after a time a reversion of soluble phosphate to the insoluble form, a process of grading is practiced at the mines whereby the crude product is separated into low-grade phosphate, rich in oxide of iron and alumina, and high-grade phosphate containing less than 3 per cent of these substances. The former is ground to an impalpable powder (floats) and sold for application to the soil without further treatment. The high-grade phosphates are shipped to the manufactories for conversion into superphosphate. The principle involved in the preparation of superphosphate is briefly explained below.

If the crude phosphates were pure tri-calcium phosphate each 100 pounds of it would require 63.2 pounds of pure sulphuric acid for its complete reduction, but as these phosphates always contain admixtures of other substances, we must take account of these impurities in calculating the amount of acid to be used. For instance—

100 pounds of ferric oxide requires 183.8 pounds of pure sulphuric acid.
100 pounds of alumina requires 288.3 pounds of pure sulphuric acid.
100 pounds of calcium carbonate requires 98 pounds of pure sulphuric acid.
100 pounds of magnesium carbonate requires 116.6 pounds of pure sulphuric acid.
100 pounds of calcium fluoride requires 125.6 pounds of pure sulphuric acid.

Given the composition of a phosphate, the sulphuric acid required for reduction can be readily computed from this table. For example:

Analysis of phosphate.	Per cent.	*Sulphuric acid.* Pounds.
Ferric oxide	0.48	0.48 by 183.8= 0.88
Alumina	2.96	2.96 by 288.3= 8.52
Calcium carbonate	3.41	3.41 by 98.0= 3.33
Calcium fluoride	1.86	1.86 by 125.6= 2.37
Tri-calcium phosphate	86.45	86.45 by 63.2=54.46
Total for 100 pounds of rock		69.56

Thus, 100 pounds of 86 per cent phosphate, treated with 69 pounds of pure sulphuric acid yields a mixture containing about 64 pounds of superphosphate and 76 pounds of gypsum or calcium sulphate, besides various impurities. Of the latter, the oxide of iron and alumina are the most important, since these compounds are known to cause a reversion of the soluble phosphate to less soluble forms. (*Fla. B. 10.*)

The phosphates of North Carolina described above have been made into superphosphates with good success both as regards amount of acid required (550 to 650 pounds of 47 per cent acid to 1,000 pounds of rock) and quality of product obtained, the latter being used along with high-grade superphosphate in experiments on various crops with highly satisfactory results. (*N. C. R. 1884, p. 87.*)

EXPERIMENTS.—The difficult availability of the phosphoric acid in fine ground phosphate or floats has led to their use in connection with green manures, and in composts with stable manure, cotton seed, and other organic manures, the fermentation of which in the soil renders the phosphoric acid more available. This method of use was first advocated by Dr. Ravenel, of South Carolina, Prof. Jameison, and Baron H. Liebig (*N. C. R. 1885, p. 56*), and has been practiced with good success at some of the southern stations, noticeably those of Alabama, where experiments in composting with cotton-seed meal have been carried on with encouraging results for some time. (*Ala. College B. 16, n. ser.*)

The comparative fertilizing value of the phosphoric acid of raw and treated phosphates has been the subject of much inquiry by the stations. While the results have often been conflicting and inconclusive the experiments have in general supported the accepted belief in the ready availability of the soluble forms and the lasting effect of the insoluble phosphates, the only exceptions apparently being the basic slag which probably on account of its excess of lime decomposes rapidly in the soil, yielding its phosphoric acid readily to plants.

A brief synopsis of experiments in this line is given below. Three years' experiments on cotton in Alabama with superphosphate, reduced or reverted phosphate (prepared by adding fine-ground phosphate to superphosphate), and floats gave inconclusive results, but indicated the permanent or cumulative effect of floats. Experiments in adding air-slaked lime to the phosphates in the drill gave inconclusive results. (*Ala. College B. 5, n. ser.*).

Tests on the limestone soils of Pennsylvania of the relative value for corn, oats, wheat, and grass, of bone, soluble phosphoric acid, reverted phosphoric acid, and insoluble phosphoric acid carried on for six years indicated the general superiority of bone and that the value of the others was in inverse ratio to thsir solubility. (*Pa. R. 1888, p. 124, R. 1889, p. 159*).

Comparisons of like amounts of phosphoric acid in the form of acid phosphate, reduced phosphate, Thomas slag, and floats on corn in South Carolina indicated that the cheaper forms are as effective as the more expensive. On cotton the order of effectiveness was acid phosphate, reduced phosphate, floats, and slag. In comparative tests on oats of Thomas slag and floats the former proved more effective. (*S. C. R. 1888, p. 151.*)

The New Jersey Station concludes from experiments on wheat with like amounts of phosphoric acid, superphosphates prepared from boneblack, bone ash, and South Carolina rock that available phosphoric acid is of practically the same value from whatever source derived. (*N. J. R. 1889, p. 147.*)

The Connecticut State Station (*R. 1889, p. 203*) has given much attention to comparative tests of superphosphates and various insoluble phosphates. Experiments with dissolved boneblack, Grand Cayman Island phosphate, Thomas slag, South Carolina phosphate, Bolivian guano, and Mona Island guano on corn, potatoes, and buckwheat extending over three years, resulted in showing in general that the soluble phosphoric acid was exhausted in from one to two years, while the other forms were more lasting. In a three-years' test on corn, Thomas slag and Grand Cayman Island phosphate were more effective than dissolved boneblack. In a two-years' experiment on potatoes the slag proved about as available as dissolved boneblack. (*Conn. State R. 1889, p. 203.*)

Experiments have been made by the Vermont Station (*R. 1888, p. 89*) with floats, fine ground boneblack, acid phosphate, and slag on corn, potatoes, and grass grown on light and heavy soil. With corn on light sandy soils the soluble phosphates gave best results. "On the heavy moist clay ground the insoluble phosphates gave just about the same weight of crop as the soluble, but it was noticed that the proportion of grain was greater and the corn ripened earlier when soluble phosphates were used." On potatoes almost the reverse was observed, the best result being obtained with slag. In box experiments with corn slag proved almost as effective dollar for dollar of cost as the soluble forms (*B. 15*).

According to experiments by the Georgia Station (*B. 2*) the order of effectiveness of certain phosphates on cotton is as follows: Acid phosphate, Thomas slag, and floats.

The results of six years' experiments at the Maine Station with mixtures of ground bone, dissolved boneblack, and South Carolina rock on oats, peas, and hay may be summarized as follows: On sod lands all the phosphates were effective; with oats dissolved boneblack yielded on the average the largest crop; and with peas and hay little difference was noted (*R. 1891, p. 126*).

In pot experiments with oats at the same station (*R. 1889, p. 140*) the order of effectiveness of the various phosphates used was as follows: Acid phosphate, Caribbean Sea guano, and floats.

Comparative tests at the Massachusetts State Station (*R. 1891, p. 203*) of equal money values of dissolved boneblack, slag, Mona Island guano, ground apatite, and floats with potatoes in 1890 showed the marked superiority of the dissolved boneblack; tests with wheat on the same land in 1891 favored dissolved boneblack as regards total yield, although the increased yield was "due in an exceptional degree to the large production of straw and chaff."

(*Ala. College B. 4 (1884), B. 8, B. 14, B. 16, B. 22, n. ser.; Conn. State R. 1889, p. 203; Fla. B. 10, B. 13; Ga. B. 2; La. B. 1, n. ser.; Me. B. 12, R. 1889, p. 140, R. 1890, p. 79, R. 1891, p. 126; Md. B. 6; Mass. State R. 1891, p. 230; N. J. R. 1889, p. 147; N. C. R. 1882, p. 112, R. 1883, p. 71, R. 1884, p. 44, R. 1885, p. 80, R. 1889, p. 41; Pa. R. 1888, p. 124; S. C. R 1888, p. 184; Vt. B. 15, R. 1888, p. 85, R. 1890, p. 20.*)

Phosphoric acid.—See *Fertilizers.*

Physalis.—Three species of this genus are cultivated for fruit, known under the various names of alkekengi, husk tomato, strawberry tomato, winter or ground cherry, and Cape gooseberry. The species are distinguished, their botanical history noted, and information about their adaptations given in *N. Y. Cornell B. 37.* The plant is an herb which bears a berry inclosed in an enlarged and persistent calyx. The common strawberry tomato is *P. pubescens,* long known in cultivation, but also found wild in this country. "The plant is very prolific, and the fruits are considerably earlier than in other species. When ripe, the fruits fall, and if the season is ordinarily dry they will often keep in good condition upon the ground for three or four weeks. The fruits will keep nearly all winter if put away in the husks in a dry chamber. They are sweet and pleasant, with a little acid, and they are considerably used for preserves and sometimes for sauce." An objection to this species is that it is of a spreading habit, thus occupying too much ground.

The second species, *P. peruviana,* is a stronger grower, somewhat erect, but too late in fruiting for a northern latitude. It is sometimes called Cape gooseberry; the former, dwarf Cape gooseberry.

The third, *P. capsicifolia,* erroneously called *P. edulis,* is an interesting plant botanically, but the fruit has a mawkish flavor.

Five species and varieties of "alkekengi" were grown at the New York State Station (*R. 1883, p. 194, R. 1886, p. 252*). See also *Nebr. B. 12.*

Piggery.—Descriptions are given as follows: *Canada Experimental Farms R. 1890, p. 57; N. Y. State R. 1889, p. 65; Wis. R. 1888, p. 154.*

Pigs.—The work of the stations on pigs consists of tests of breeds and feeding experiments, chiefly the latter. The subject of pig feeding has been very extensively studied by certain of the stations, and their work in this line is unusually interesting to the farmer from the fact that the experiments are almost exclusively of a purely practical nature. The experiments are in themselves simpler than those with most other animals, for as a rule only a single question is involved, namely, the effect of the food on the cost and rate of gain in live weight. In some few cases, however, studies of physiological questions have been included, as the effect of different food combinations on the relative production of fat and lean pork, on the strength of the bones, size of internal organs, etc. No attempt will be made to treat the subject of pig feeding exhaustively here, but rather to call attention to some of the lines which have been most thoroughly studied. The subject is subdivided as follows: (1) Skim milk; (2) whey; (3) corn alone and in combination with other feeding stuffs; (4) peas; (5) oats; (6) potatoes; (7) coarse and green fodder; (8) salt; (9) cooking and steaming food; (10) moistening or soaking food; (11) feeding for fat and for lean; (12) nutritive ratio; (13) physiological effects of feeding; (14) pigs from mature and immature parents; (15) weight or age as a

factor in determining profit; (16) cost of feeding before and after weaning; (17) summer treatment, and (18) protection. A brief account of the tests of breeds is given at the end of this article.

PIGS, SKIM MILK AS FOOD.—Skim milk as the station experiments have shown, forms one of the best and most economical bases for a ration for growing pigs. Although corn is the food by far the most extensively used for pigs, it produces excessively fat pork when fed alone. Skim milk has the very great advantage of being a nitrogenous food. Fed in connection with corn meal it produces a leaner pork, usually at a lower cost, which commands a higher price than very fat pork. The Massachusetts State Station keeps a pig for every milch cow to drink the skim milk.

Experiments in which skim milk has been used have been in progress at the Masschusetts State Station since 1884 *(R. 1884, p. 68, R. 1885, p. 23, R. 1887, p. 55, R. 1888, p. 55, R. 1889, p. 103)*. In these experiments two conditions have been considered, (1) a large supply of skim milk, and (2) a limited one. In considering the first condition the plan has been to mix corn meal with the skim milk in the following proportions:

Live weight of animal.	Corn meal per quart of milk.
Pounds.	*Ounces.*
20 to 70	2
70 to 130	4
130 to 200	6

Where the supply of skim milk has been limited, the milk has been supplemented by the following grain mixtures extended with water:

Live weight of animal.	Grain mixture (parts by weight).		
	Gluten meal.	Wheat bran.	Corn meal.
Pounds.			
20 to 70	2	1	....
70 to 130	1	1	1
130 to 200	1	1	2

The aim has been under both conditions to feed rations having the following nutritive ratios: With pigs weighing from 20 to 70 pounds, 1 : 2.8 to 1 : 3; with those weighing from 70 to 130 pounds, 1 : 3.6 to 1 : 4; and with those weighing from 130 to 200 pounds, 1 : 4.5 to 1 : 5. The pigs were fed all they would eat up clean.

As a result of these experiments the following statements are made:

"(1) Begin as early as practicable, with a well-regulated system of feeding. During the moderate season begin when the animals have reached from 18 to 20 pounds in live weight; in the colder seasons, when they weigh from 25 to 30 pounds.

(2) The food for young pigs during their earlier stages of growth ought to be somewhat bulky, to promote the extension of their digestive organs and to make them thereafter good eaters. A liberal supply of skim milk or buttermilk, with a periodical increase of corn meal, beginning with 2 ounces of corn meal per quart of milk, has given us highly satisfactory results.

(3) Change the character of the diet at certain stages of growth from a rich nitrogenous diet to that of a wider ratio. * * * Begin, for instance, with 2 ounces of corn meal to 1 quart of skim milk; when the animal has reached from 60 to 70 pounds, use 4 ounces per quart, and feed 6 ounces of meal per quart after its live weight amounts to from 120 to 130 pounds."

The Wisconsin Station found (*R. 1883, p. 33*) that when skim milk and corn meal were each fed *ad libitum* to separate lots of pigs, the pigs on skim milk made somewhat the larger gain. To produce a pound of gain, 4 pounds of corn meal or 19 pounds of skim milk were consumed. When the two were mixed the indications were that "much corn meal should be fed with the skim milk, since the meal furnishes largely carbohydrates and the skim milk largely protein." The greatest gain for the food eaten occurred when 2 pounds of meal was fed with 3⅛ pounds of skim milk.

At the Maine Station (*R. 1889, p. 103*) when skim milk was substituted for a part of the corn meal without changing the amount of digestible food eaten, the ration was more efficient, but there was a limit to this replacement. For instance, a ration, one-third of whose nutrients was furnished by skim milk, proved to be practically as efficient as one in which two-thirds of the nutrients were from skim milk. Pigs fed all they would eat of a mixture of 1 pound of corn meal and 3 pounds of skim milk made an average gain in fifty-five days of 83 pounds, requiring 9.51 pounds of skim milk and 3.17 pounds of corn meal per pound of gain (*Wis. R. 1888, p. 93*). Another trial (*Wis. R. 1888, p. 96*) indicated "that to produce pork rapidly a large proportion of skim milk to corn meal may be fed, but that such feeding is not the most economical, and that a pound or a pound and a half of skim milk to 1 pound of corn meal is as much as can profitably be fed when skim milk is valued at 20 to 25 cents and corn meal at 75 cents per 100 pounds." Pigs weighing 400 pounds each and others weighing 140 pounds were given all they would drink of skim milk, with a little corn meal stirred into it, for sixty-three days (*Wis. R. 1889, p, 24*). The lighter pigs ate much less per pound of gain than the mature ones.

Experiments at the Vermont Station (*B. 18*) also brought out the value of skim milk for growing pigs. It is calculated that with pork at 5¼ cents per pound, dressed weight, there was received for the skim milk fed, on an average, 24 cents per 100 pounds, or 2.13 cents per gallon.

Other authorities have stated that with proper feeding 200 pounds of skim milk is equivalent to a bushel of corn.

The New Hampshire Station (*B. 11*) compared a mixture of two parts, by weight, of skim milk and one part of corn meal with a mixture of equal parts of wheat middlings and corn meal for one hundred and thirty-three days. The two rations contained like amounts of total digestible food, and were fed so as to furnish 0.53 to 0.54 pound of protein and 3.33 to 3.36 pounds of carbohydrates and fat per 100 pounds, live weight, per day. "The rate of gain was unmistakably greater on the skim milk and corn meal than on grain alone, while the cost of growth [with skim milk at 25 cents per 100 pounds and corn meal at $20 and middlings at $26 per ton] was from 1.2 to 1.19 cents greater per pound when the food was mixed grain. On grain alone there was a loss of more than 1 cent for every pound of growth. * * * With thrifty pigs, from 20 to 30 cents per hundred can be realized for skim milk when live hogs sell at 4 cents per pound. It must be constantly kept in mind, however, that they must be sold by the time they reach 200 to 230 pounds, live weight." The average cost of food per pound of gain, at the above prices, was 3.6 cents on skim milk and corn meal and 5.2 cents on the mixed grain.

Skim milk vs. buttermilk.—These were compared in two series of experiments at the Massachusets State Station (*R. 1884, p. 68, R. 1885, p. 23*), feeding corn meal with each. The skim milk contained a fifth more solids than the buttermilk; but in spite of this in the first trial when they were fed in equal quantities there was little if any difference in the gain in weight, and for the amount of dry matter eaten the buttermilk proved most nutritious, for on the buttermilk ration 2.4 pounds and on the skim-milk ration 2.9 pounds of dry matter were eaten per pound of dressed pork.

In the second experiment the two rations were adjusted so as to furnish like amounts of dry matter instead of like quantities of milk and corn meal. The result was then

better on the skim-milk ration than on the other. With buttermilk at 1.37 cents and skim milk at 1.8 cents per gallon, the buttermilk was somewhat the cheaper; at the same price per gallon the skim milk would have been the cheaper.

The Wisconsin Station (*R. 1886, p. 24*) compared skim milk with buttermilk, feeding each in like amount and mixed with corn meal. The pigs on skim milk made a slightly larger gain than the others. With pigs at 5 cents per pound and corn meal and shorts at $15 per ton, "the skim milk would have a value of 35 cents and the buttermilk 28 cents per 100 pounds."

PIGS, WHEY AS FOOD.—The Wisconsin Station (*B. 27, R. 1891, p. 38*) reports four trials in feeding whey. "We were not successful in maintaining pigs on whey alone. * * * Added to a corn-meal and shorts mixture it produced a marked saving in the grain required for good gains. * * * If corn meal and shorts are valued at $12 per ton, then whey is worth 8 cents per 100 pounds; at $15 per ton for the corn meal and shorts whey would be worth 10 cents per 100 pounds.

PIGS, CORN AS FOOD.—Prof. Henry of the Wisconsin Station (*R. 1889, p. 36*) says: "Corn is and has been the almost universal food for swine in this section, and so it is to Indian corn that we are indebted for the benefits accruing from the hog. No other plant furnishes so much available food to the acre or food that is so well relished by the hog as corn. * * * Since it is the cheapest food on the list, corn very probably may form part of the ration of hogs at all times, but to cause a brood sow not only to maintain her own life but to grow the bodies of a litter of young from the elements contained in the daily ration of corn is simply out of the question. There are not enough bone and muscle elements in the corn a brood sow can consume to suffice for building up the bodies of her young. * * * Intelligently fed, corn is all right; only in its abuse is there any wrong. There need be no less corn fed, but more protein food should be given in the shape of clover, blue grass, oats, and other grains." The Illinois Station (*B. 16*) found that "in no case did pigs make satisfactory gains after six or eight weeks feeding on corn alone." A summary of the results of sixteen different trials at the station, where pigs were fed exclusively on corn, shows that the gain in weight per bushel of shelled corn ranges from 8.66 to 16.81 pounds, being over 11 pounds per bushel in ten out of the sixteen trials. As the average of four trials at the same station (*B. 16*), pigs on a "full" ration of corn with pasturage made larger gains than either those on a half ration of corn with pasturage, or on corn alone, although the rate of gain for the corn eaten was on the whole rather better in the case of the pigs having pasturage and a half ration of corn.

Whole corn vs. ground corn.—A decided difference of opinion exists among farmers in regard to the relative merits of corn when fed whole and when fed ground (corn meal). It should be borne in mind that there is no difference in the composition of the two and that any difference there may be in feeding effect is due to difference in digestibility or palatability. The question is, does grinding corn for pigs pay financially?

The Maine Station (*R. 1885–'86, p. 59*) found in digestion trials that pigs digested a larger proportion of the protein, fat, and carbohydrates of corn meal than of whole corn. The results were as follows:

Percentage of nutrients digested from whole corn and corn meal.

	Dry matter.	Protein.	Crude fiber.	Crude fat.	Nitrogen-free extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Whole corn	82.5	68.7	38.3	45.6	88.8
Corn meal	89.5	86.1	29.4	81.7	94.2

A careful trial at the Maine Station (*R. 1887, p. 97*) failed to reveal any difference in feeding value, the gain on corn meal being only 2 pounds greater than on whole

corn when the two were fed in like quantities. Reckoning the whole corn at 64 cents per bushel and the corn meal at $1.20 per 100 pounds, the cost per pound of gain was very slightly larger on corn meal. In a repetition of the experiment (*Me. R. 1888, p. 101*) the gain was a little larger on the whole corn. "The results of the two years' experiments are certainly favorable to feeding whole corn, for it seems to produce as much gain, pound for pound, as corn meal, and the cost of grinding is at least saved."

In a trial at the Wisconsin Station (*R. 1888. p. 92*), using pigs ranging from 175 to 320 pounds in weight, with the heavy pigs corn meal gave the best results and with the lighter pigs whole corn. The conclusion was that grinding would hardly pay.

The inference from an experiment reported by the Missouri Agricultural College (*B. 1*) was that corn meal was more effective than whole corn when the two were eaten in similar amounts.

The Alabama Canebrake Station (*B. 8*) reports a trial with pigs weighing about 80 pounds, part of which were fed corn meal and the rest whole corn *ad libitum*, which was decidedly favorable to corn meal as far as gain was concerned and slightly so from a financial standpoint. "When butchered the meat of those fed upon corn meal was whiter and firmer than that of the corn-fed pigs."

Results at the Kentucky Station (*B. 19*) were conflicting. In the first trial they were practically the same for the corn meal and the whole corn lots, the gain in weight being 175 pounds for the former and 182 pounds for the latter. In the second trial the gain of the corn meal lots was considerably the larger.

The weight of evidence, then, seems to be against grinding corn for pigs.

Corn meal vs. corn-and-cob meal.—The corn cob has a certain feeding value of itself, and is generally believed to be beneficial to digestion when ground with corn. It adds a certain amount of ash ingredients to the meal and is often recommended on that account. Digestion trials with pigs at the Maine Station (*R. 1885–'86, p. 62*) indicated corn-and-cob meal to be less digestible than corn meal, but rather more so than whole corn kernels. The same station (*R. 1887, p. 99*) compared a daily ration containing 4 pounds of corn meal with one containing 5 pounds of corn-and-cob meal for eighty-one days. The three pigs in the corn-meal lot gained 136 pounds and the three in the corn-and-cob meal lot 129 pounds.

At the Kentucky Station (*B. 19*) pigs fed exclusively on corn-and-cob meal wasted it badly, and on an average made 1 pound of gain for every 6.1 pound of corn-and-cob meal.

Pigs following corn-fed steers.—The value of the manure from corn-fed steers for pigs has been the subject of a number of separate trials at the Wisconsin Station (*R. 1884, p. 25, R. 1886, p. 62, R. 1888, p. 89*). In these trials pigs have been allowed to run with steers fed either whole corn or corn meal, the pigs receiving sufficient corn to satisfy them in addition, and the results compared with those of pigs fed corn in pens. In the first trial the pigs running with steers required only 3.4 pounds of corn per pound of gain, while those kept in pens required over 5 pounds. "Putting it in another way, a bushel of shelled corn made 11.4 pounds of pork when fed alone to hogs, while a bushel fed to hogs running with corn-fed steers made, with the help of the droppings of the steers, 17.6 pounds, or over one-half more." In two other trials pigs following steers fed shelled corn required less than one-half as much additional corn to make a pound of gain as pigs fed in a pen by themselves, and pigs following steers fed corn meal required somewhat less (about 17 per cent) than pigs fed by themselves. In a fourth series "the hogs with steers getting corn meal lost rather than gained by the association, while the hogs following corn-fed steers required very little extra feed in the first trial and none at all in the second to cause them to make good gain."

In similar experiments at the Illinois Station (*B. 16*), except that no additional

food was fed to the pigs following cattle, fair gains were made, although smaller ones than by pigs on pasturage and a full corn ration.

Corn meal vs. shorts, bran, and middlings.—Corn meal, shorts, and a mixture of equal parts of the two by weight were compared at the Wisconsin Station (*R. 1885, p. 33*), feeding as much of each ration as was eaten clean. To produce a pound of gain there was eaten 5.3 pounds of either the corn meal or shorts, or 3.3 pounds of the mixture. The mixture was the cheapest feed, costing 3.3 cents per pound of gain. In another trial, counting shorts at 70 cents per 100 pounds and corn at 35 cents per bushel, the cost of pork production on a mixture of two parts of ear corn to one of shorts was from 4.1 to 4.4 cents per pound, and on ear corn alone 4.6 to 4.8 cents per pound.

In a later trial (*Wis. R. 1890, p. 21*), when shorts, bran, and corn meal was compared with corn meal alone, the lot fed shorts, bran, and corn meal made a far more rapid and economical growth, had stronger bones, more ash in their bones, and a larger proportion of lean pork.

The Kansas Station (*B. 9* and *Rep. Sec'y Kans. State Bd. of Agriculture, 1889*) compared cooked corn meal with a mixture of cooked shorts and bran in two experiments. In the first trial, with mature hogs, the corn-fed lot ate the most and made the greatest gain, but required more food to make a pound of gain than the lot fed shorts and bran; but in the second trial, where young pigs were used (68 pounds), the result was reversed.

In a single trial at the Vermont Station (*R. 1890, p. 114*), "in every case corn meal gave better results than wheat middlings as food for young growing pigs."

This result was reversed at the Missouri Agricultural College (*B. 10*), where 94 pounds of "ship stuff" gave the same gain as 100 pounds of corn meal. This has been the continuous result for six years.

As between wheat bran and middlings, the Maine Station (*R. 1890, p. 69*) reports that in one experiment with pigs weighing about 200 pounds "the growth from the middlings ration was over twice that from the bran ration."

Corn meal vs. barley meal.—In two comparisons of these feeds at the Wisconsin Station (*R. 1890, p. 53*), in one of which they were each fed alone and in the other with skim milk, a little more barley meal (about 8 per cent) was required per pound of gain than of corn meal. The results at the Massachusetts State Station (*R. 1889, p. 112*) pointed in the same direction. More recently, in experiments at the Minnesota Station (*B. 22*), 100 pounds of barley meal was found to be equivalent to 119.5 pounds of corn meal when each was fed as the entire ration; when each was fed with shorts or oil meal the barley meal was found fully equal to corn meal. Other comparisons at the same station were less decisive.

Corn meal vs. rice meal or rice bran.—At the Vermont Station (*R. 1890, pp. 114, 125*) corn meal gave better results than either rice meal or rice bran, producing on the average about a quarter more gain in live weight with the same amount of food.

Corn meal vs. cotton-seed meal.—The Texas Station (*B. 21*) compared shelled corn with cotton-seed meal and cotton seed. The lot receiving corn alone made the largest and cheapest gain in live weight, and the lot receiving boiled cotton seed the next best. In the first trial ten out of twenty and in the second trial seven out of fifteen pigs died within ten weeks after beginning to feed the cotton seed or cotton-seed meal.

At the Kentucky Station (*B. 19*) "cotton-seed meal could not be fed profitably to hogs either for growth or fat."

Corn meal vs. sorghum seed meal.—Four trials at the Wisconsin Station (*R. 1883, p. 27*) indicated sorghum-seed meal to be a little more than half as valuable as corn meal.

Corn meal alone and mixed with various feeds.—Several experiments have been reported which show the good effects of adding some nitrogenous food to corn meal, especially for young growing pigs. Thus at the Maine Station (*R. 1889, p. 101*) "a

mixture of pea meal and corn meal or of gluten meal and corn meal proved to be much more efficient than corn meal alone in feeding animals already well grown and quite fat." Likewise at the Virginia Station (*B. 10*) a mixture of 10 parts of corn meal, 4 of bran, and 1 of beef scrap gave a larger and more economical gain than corn meal alone. Results at the Massachusetts Station (*R. 1892, p. 92*) are favorable to a mixture of corn meal, wheat bran, and gluten meal, changed to give a less nitrogenous ration as the pigs increased in weight. (*Ky. B. 19; Mass. State R. 1883, p. 40; N. Y. State B. 22, n. ser.; Wis. R. 1888, p. 100.*)

Effect of adding ashes, bone meal, etc., to corn.—As already mentioned, corn is deficient in ash or bone-making constituents, so that pigs fed exclusively upon it have weak or brittle bones. The Wisconsin Station (*B. 25, R. 1889, p. 15, R. 1890, p. 33*) reports three trials of feeding hard-wood ashes or bone meal with corn when the diet was corn alone. "The effect of the bone meal and ashes was to save about 130 pounds of corn, or 28 per cent of the total amount fed in producing 100 pounds of gain, live weight. By feeding the bone meal we doubled the strength of the thigh bones; ashes nearly doubled the strength of the bones. There was about 50 per cent more ash in the bones of the hogs receiving bone meal and hard-wood ashes than in the others.

"A careful examination revealed no difference in the proportion of lean to fat meat in the several carcasses. * * * These experiments point to the great value of hard-wood ashes for hog feeding, and show that they should be regularly fed. Bone meal seems to build up somewhat stronger bones than ashes, but ashes do the work well enough and usually cost nothing with the farmer. Where they can not be obtained, bone meal is strongly recommended."

Hard well water containing 40.6 grains of solids per gallon showed no advantage over rain water with 6.44 grains per gallon (*Wis. R. 1889, p. 13*). In 1888 the station showed the effect of skim milk and shorts (*R. 1888, p. 105*). "Where the most skim milk was fed the bones were the strongest. Shorts made a strong bone, but not quite equal to that produced by skim milk."

PIGS, PEAS AS FOOD.—Successful and encouraging results from the use of peas with other grains, as barley, oats, middlings, have been reported by the Utah Station (*R. 1891, p. 20*) and Ontario Agricultural College and Experimental Farm (*R. 1890*).

At the Maine Station (*R. 1889, p. 85*) "a mixture of pea meal and corn meal or of gluten meal and corn meal proved to be much more efficient than corn meal alone in feeding animals already well grown and quite fat."

Prof. Henry says (*Wis. R. 1889, p. 40*): "Where peas can be grown they are admirable protein food and should make a choice quality of pork. Peas can be sowed broadcast in early spring, and when ripening can be fed down by hogs at no expense for gathering the crop."

PIGS, OATS AS FOOD.—In comparison of whole and ground oats at the Wisconsin Station (*R. 1889, p. 20*) the ground oats gave the better results for food eaten.

Ground oats fed to sows with sucking pigs gave unsatisfactory results with oats at $18 per ton (*Wis. R. 1890, p. 52*).

PIGS, POTATOES AS FOOD.—The Wisconsin Station reported (*R. 1890, p. 59*) a trial in which potatoes were fed alone and with corn meal and shorts. The cooked potatoes were better relished when quite dry. "It required nearly 4½ pounds of potatoes to take the place of one pound of corn meal. * * * It appears that the dry matter of corn meal was superior to an equal amount in potatoes. The trial with shorts and potatoes shows that shorts did not give quite as good results with the potatoes as did corn meal."

As the result of a trial at Kansas Station (*B. 9*) it is stated that potatoes fed with corn "were of undoubted value, considered either as an appetizer or true food." The potatoes and corn were cooked together, and were better relished so than raw.

PIGS, COARSE AND GREEN FODDER—*Silage vs. roots.*—A trial of feeding corn silage to pigs at the Wisconsin Station (*R. 1888, p. 86*) resulted unsatisfactorily. The

results at the New York State Station (*R. 1890, p. 141, B. 22, n. ser.*) with silage made from corn ripe enough to cut for husking "show that with silage rated so low as $1 per ton the gross cost for production of pork was considerably more than its market value when the proportion of silage was about 70 per cent of the ration." When corn took the place of part of the silage, the silage forming an average of 44 per cent of the total food, the gross cost of pork was about the same as where no silage was fed. "The silage was never all swallowed even when fed in very small quantities, although after the grain had been eaten out the remainder was chewed."

The Ontario Agricultural College Station (*B. 64, R. 1890*) has reported two trials in which silage has been compared with turnips, feeding a grain ration in connection with each. The turnips served rather better than the silage, but neither gave very satisfactory results.

The New York State Station (*B. 28, n. ser.*) reports that mangel-wurzels were eaten without waste and at $2 a ton usually gave a profit.

Clover, alfalfa, oat, and pea forage.—In two trials at New York State Station (*B. 28, n. ser.*) in which green clover formed the principal part of the diet, the gain made was very small. Oat and pea forage gave better results, but at the current prices "would only be profitable with the forage at about $2 per ton." (*N. Y. State B. 28, n. ser.*)

The Utah Station reports (*R. 1891, p. 20*) "alfalfa during winter in the dry state and in summer in the green state was economically added to wheat. Peas proved a good pork producer. Coarse foods, as heretofore, when fed to young pigs produced slow growth.

Prickly comfrey.—Two trials of this at New York State Station (*B. 22, n. ser., B. 28, n. ser.*) proved unsatisfactory, as the pigs refused to eat enough of it to maintain their weight.

Sorghum.—The gain of pigs fed largely on sorghum with a small grain ration was profitable when salt was fed, with sorghum rated at $2 per ton (*N. Y. State B. 22, n. ser.*).

PIGS, SALTING.—The New York State Station (*B. 22, n. ser., B. 28, n. ser.*) reports a larger gain with than without salt when the pigs were fed largely on coarse foods. "While feeding clover, corn silage, sorghum, etc., better results have generally attended the ration to which salt has been added, but whenever mangel-wurzels have been fed, the pigs having salt have generally made much poorer gains."

PIGS, COOKING AND STEAMING FOOD.—Cooking or steaming the food very naturally suggests itself as a means of improving the ordinary method of feeding pigs. The process has been widely recommended and practiced, but the experience of the experiment stations has failed to justify it, as the following summary will show. At the Michigan Agricultural College (*B. 4*) two lots of Poland China and Essex pigs were fed two parts of corn and one part of oats ground together, the feed being stirred up with boiling water for one lot, and with cold water for the other. The amount of food eaten per pound of gain was 4.62 pounds of cooked and 4.7 pounds of uncooked food, a difference entirely too small to be counted in favor of the cooking. At the Kansas Agricultural College (*R. 1885–'86*) Prof. Shelton compared cooked with uncooked shelled corn. The corn was cooked by steam until it could easily be crushed between the fingers. The amount eaten per pound of gain was 7.5 pounds of cooked and 6.3 pounds of raw corn; the average gain per pig was 104 pounds for the lot fed cooked and 151 pounds for the lot fed raw corn. "The figures given need but little comment. They show as conclusively as figures can show anything that the cooked corn was less useful than the raw grain, the difference in favor of the raw corn amounting to one-fifth."

The Iowa Agricultural College (*Coburn's Swine Husbandry, p. 134*) compared cooked whole corn and corn meal with the same uncooked for a period of four months during summer, one lot being fed each food. The gains were as follows: On dry corn, 195 pounds; on cooked corn, 162 pounds; on dry corn meal, 202 pounds; on cooked corn meal, 142 pounds. The gain was 13 pounds per bushel on dry corn, as com-

pared with 10.8 pounds on the same cooked, and 13.46 pounds per bushel on dry meal as compared with 9.46 pounds on cooked meal. It is evident that the results favor the raw food.

Cooked and uncooked corn meal were compared at the Maine Agricultural College (*R. 1878, p. 43*) each year for nine years. Without an exception the raw meal gave better results than the cooked meal. The uniformity of this result entitles it to much weight.

Later the same station (*R. 1887, p. 100*) compared cooked and raw potatoes fed in like amount with corn meal and milk. Some of the pigs did not eat the raw potatoes at all readily. In forty-four days the gain for two pigs was 60 pounds on raw and 67 pounds on cooked potatoes, indicating "that the value of potatoes is not materially increased by boiling."

The Wisconsin Station (*R. 1885, p. 36, R. 1886, p. 67*) reports ten trials in which corn meal, corn meal and shorts, whole corn and shorts, and barley meal were each fed raw and cooked. "The results of the trials with each and every one of the several food articles used are against cooking." The result was especially marked in case of corn and corn meal, alone or with shorts.

Raw and cooked peas were compared in two experiments at the Ontario Agricultural College (*R. 1876, p. 18*). In the first trial there was eaten per 100 pounds of gain in live weight, on an average, 484 pounds of raw or 519 pounds of cooked peas, and in the second trial 360 pounds of raw or 475 pounds of cooked peas.

The inference from these twenty-four separate trials is that there is no advantage, if not a positive loss, in cooking food for fattening pigs. In partial explanation of this it may be stated that the New York State Station (*R. 1885, p. 320*) found the nitrogenous materials in cooked corn and corn meal to be less completely digested than in the raw state. Further than this, the Wisconsin Station (*R. 1886, p. 82*) found that as a rule pigs were inclined to eat less heartily of cooked than of raw food; and that they ate the ration of moist cooked food much more rapidly than the same food raw. With barley meal four times as long, and with corn meal over twice as long was taken to eat the dry as the cooked food. In eating slowly the food is much more thoroughly mixed with the saliva, which materially aids digestion.

PIGS, MOISTENING OR SOAKING FOOD.—Two trials at the Wisconsin Station (*R. 1888, p. 94*) of feeding a mixture of corn meal and shorts, dry and moistened with water, both resulted favorably to the wet food. The pigs ate more of the wet food, made larger total gains on it, and larger gains for the food eaten, than when the same was fed dry. In two trials at the Illinois Station (*B. 16*) in which whole corn was fed as the exclusive food either dry or soaked in water, the pigs on soaked corn ate more and gained more than those on dry corn. In one trial they gained more and in the other less in proportion to the food eaten than those fed dry corn, although the differences were not large in either case.

PIGS, FEEDING FOR FAT AND FOR LEAN.—Experiments by Prof. Sanborn at the Missouri Agricultural College in 1884, 1885, and 1886 (*Buls. 9, 10, 14, and 19*) strongly indicated that the character of the food influenced the character of the pork produced, and that such nitrogenous foods as shorts, middlings, and dried blood, as compared with corn meal fed alone, tended to increase the proportion of lean pork to fat. The matter was taken up by Prof. Henry, of Wisconsin, in 1886, and by several others later. Reports of experiments in this line at the Wisconsin Station are given in *R. 1886, p. 86, R. 1888, p. 96, R. 1890, p. 21,* being usually accompanied by plates showing the relative proportion of fat and lean in different cuts of the carcasses. Prof. Henry assumes that the hog by long-continued excessive feeding on corn has become abnormally fat, and that by adequate feeding it can be brought back to its normal condition, having a good muscular development. This, however, he states, holds true "only while the animal is young and growing, and that the age and nature limits the amount of muscle, while the fat of the body may go on increasing after maturity is reached."

His experiments all corroborate Prof. Sanborn's work. Pigs fed shorts, bran, skim milk, or dried blood produced a larger proportion of lean pork than those fed corn alone. In one trial, where the water in the flesh was determined ,it was found that pigs fed the more nitrogenous food contained a larger percentage of water-free meat in their bodies than those fed corn, showing that the increase in lean was real as well as apparent.

In discussing his four-years' experiment Prof. Henry says: "We feel warranted in maintaining that the kind of food supplied to young growing pigs has a very marked effect upon the animal carcass; that foods rich in protein tend to build up strong muscular frames and large individuals, with ample blood and fully developed internal organs; that excessive corn feeding with pigs, even after they have obtained a good start, tends to dwarf the animal in size and prematurely fatten it; that, owing to the larger amount of ash contained, and perhaps for other causes, pigs receiving the usual nitrogenous foods have stronger bones than those fed on corn; and that the bones of pigs fed on corn contain the least mineral matter. * * * After the pigs have reached the age of 7 or 8 months there is far less necessity for nitrogenous foods, and the cheapest gains can be made with corn."

Prof. Shelton, of the Kansas Station, has reported (*Quarterly Report State Board of Agriculture, 1889, Kans. B. 9*) two experiments concerning the effect of rations of corn and of shorts and bran on the composition of the carcass. The first was with mature pigs, and failed to show any material difference between the effects of the two foods. In the second, with young pigs, in the case of the lot fed shorts and bran, there was a larger proportion of lean to fat, and a larger actual amount of lean pork; the lungs, intestinal fat, and leaf lard weighed less; the blood, liver, kidneys, uterus, stomach, and tenderloin weighed more; the percentage of dry matter in the lean meat, as well as in the fat, was less, and the bones were stronger.

These results agree with those at Missouri and Wisconsin. The indications of a preliminary trial at New York Cornell Station (*B. 5*) were that a ration of corn, cotton-seed meal, and wheat bran might increase the lean meat in mature animals.

A trial at Virginia Station (*B. 10*), on the other hand, showed "not the slightest difference in the proportion of fat and lean meat in pigs fed corn alone and corn meal, beef scraps, and bran." The pigs averaged about 115 pounds each in weight at the beginning of the trial.

Here the matter rests. The weight of evidence would seem to favor the view that the proportion of lean pork can be increased within certain limits by feeding a more nitrogenous food than corn or corn meal.

PIGS, NUTRITIVE RATIO OF FOOD.—By nutritive ratio is meant, as explained under *Feeding farm animals*, the relation between the digestible nitrogenous and the digestible non-nitrogenous constituents (fat, carbohydrates, cellulose) of the ration, taking the nitrogenous constituents as 1. In general, experience has shown that the nutritive ratio of food for young pigs should be relatively narrow, widening as they get their growth. The Massachusetts State Station (*R. 1890, p. 91*) has used the following ratios: For pigs weighing from 20 to 70 pounds a nutritive ratio of 1: 2.8 to 1: 3; from 70 to 130 pounds, 1: 3.6 to 1: 4; from 130 to 200 pounds, 1: 4.5 to 1: 5. The comparisons of corn alone (carbonaceous or wide ratio) with admixtures of more nitrogenous foods, as mentioned above, have pointed out the manifold advantage of the more nitrogenous ration, *i. e.*, the narrower rations.

The Maine Station (*R. 1889, p. 85*) reports: "In six feeding periods where the rations compared contained practically the same digestible material, 2,643 pounds of digestible food with a nutritive ratio ranging from 1: 5.2 to 1: 6.1, produced 890 pounds of growth, while 2,651 pounds of digestible food with a nutritive ratio bearing from 1: 8.9 to 1: 9.4 produced 617 pounds of growth; it took nearly one-half more food to produce a pound of growth with one set of rations than with the other.

"A ratio of 1: 6 was compared with one of 1: 3.6, and one of 1: 5.6 was compared with another of 1: 4.4, the resulting growth being practically the same."

PIGS, PHYSIOLOGICAL EFFECTS OF FEEDING.—For effect of food on proportion of fat and lean pork see *Feeding for fat and for lean.*

For effect of food on strength of bones see *Corn meal for pigs,* and *Effect of adding wood ashes, bone meal, etc.*

Further literature is given as follows: Effect of food on the composition of the carcass and on the size of internal organs: *Kans. B. 9; Wis. R. 1888, pp. 13, 100; R. 1889, pp. 6, 18; R. 1890, p. 31.*

Modern feeding of pigs in its influence upon the formation of the skull and dentition: *Minn. B. 7.*

PIGS FROM MATURE AND IMMATURE PARENTS.—Two trials at the Kansas Station (*R. 1889, p. 79*) were contradictory. "In the trial of 1888 pigs from mature parents were the most profitable; in the trial of 1889 there was little difference between the two litters."

PIGS, WEIGHT OR AGE AS A FACTOR IN DETERMINING PROFIT.—One important result of systematic experiments in pig-feeding has been to show that the amount of food required to produce a pound of gain in live weight increases as the pigs advance in weight, and that beyond a certain weight the feeding becomes unprofitable. It has been repeatedly shown that there is no profit in growing heavy hogs. The profit comes from fattening the pigs as rapidly as possible and selling them for pork when they weigh 175 to 200 pounds. Prof. Goessmann says, as a result of his long study of the question, "To go beyond 175 to 180 pounds is only advisable when exceptionally high market prices for dressed pork can be secured. The quality of the meat is also apt to be impaired by an increased deposition of fat. The power of assimilating food and converting it in an economical way into an increase of live weight decreases with the progress of age." (*Mass. State R. 1889, p. 103.*) Prof. Cooke, of the Vermont Station (*B. 18*), says "Pig-feeding is profitable even at the low price of 5½ cents per pound, dressed weight, provided the pig is sold at an early age, *i. e.*, by the time it reaches a live weight of 180 pounds or soon after. Grain can be fed to young pigs with profit; in feeding it to pigs weighing over 200 pounds there is a loss."

The cost of growth at different stages is well illustrated by Prof. Cooke in the discussion of an experiment made in 1890 (*Vt. R. 1890, p. 120*).

Gain and cost of gain at different stages of growth.

	Average weight at end of period.	Average cost of food per pound of gain.	Selling price of pork per pound (live weight).	Average profit per pound of gain (live weight).
	Pounds.	*Cents.*	*Cents.*	*Cents.*
Period I	51	2.47	5	2.53
Period II	103	3.70	5	1.30
Period III	160	4.89	5	0.11
Period IV	202	5.82	5	*0.82

* Loss.

The cost is based on corn meal, gluten meal, and wheat middlings at $26 and bran at $24 per ton, and skim milk at 15 cents per hundred pounds. "On the average the 6 pigs required during the first period 159 pounds of dry matter in the food to make a pound of growth, and this amount increased steadily as the pigs increased in live weight until, during the last period, when they weighed about 200 pounds apiece, it required 3.96 pounds of dry matter in the food to produce a pound of growth. The pigs ceased to yield a profit, at the market prices then ruling, after they reached a live weight of about 180 pounds But it was found profitable then to feed them heavily for fifteen days on corn meal to 'finish them off' for the market."

The Massachusetts State Station (*R. 1885, p. 28*) gives tables equally striking.

The New Hampshire Station (*B. 11*) says, in discussing an experiment, "The cost of growth and the amount of food required to produce 100 pounds of growth increase as the pigs grow older, and it would have been much more profitable to have sold them when averaging 175 pounds each than when averaging 240 pounds."

The Maine Station (*R. 1890, p. 75*) states that "the ratio of food to growth was very different during the early part of the experiment from what it was the latter part. In Period I, including approximately the first one hundred days of the experiment, not far from 2 pounds of digestible food produced 1 pound of growth, while during the last fifty days or thereabouts the ratio was 4 pounds of digestible food to 1 pound of growth. The ratio of the second period stands between those of first and third."

PIGS, COST OF FEEDING BEFORE AND AFTER WEANING.—The Wisconsin Station (*R. 1890, p. 42*) reports two series of trials on this subject. The teaching of these trials is that it pays to feed sows when suckling pigs so heavily that even the dams will gain in weight, for the cost of the gain made by the pigs and their dam is then cheaper than the gain of the same pigs when grown.

Averaging the trials for the two years we have $2.87 as the cost of producing 100 pounds of gain with pigs before they are weaned, and $2.75 per 100 pounds gain as the cost of food for pigs immediately after weaning, a difference of $0.12 per 100 pounds' gain.

PIGS, SUMMER TREATMENT.—Regarding the question, "is it profitable to feed pigs well in summer or may they be allowed to run with little or no care and yet without much loss?" the Maryland Station (*B. 12*) reports two trials. The results of these trials for two years indicate that for fall or winter pigs, which are to be killed when about a year old, it is more profitable to let them run in pasture or woodland during the warm months and shift for themselves until within eight or ten weeks of killing time than it is to feed them in confinement during the summer."

PIGS, PROTECTION.—Goessmann states (*Mass. State R. 1889, p. 103*) that it pays to protect pigs against the extremes of the season. Feeding in the moderate season is more profitable than during very cold weather.

PIGS, BREEDS.—A number of trials have been reported by the stations on the relative pork-producing qualities of different breeds of pigs. As a rule, however, they have been with too small a number of pigs to furnish more than indications. The question of the best breed has not been settled. The Maine Station (*R. 1890, p. 75*) compared the gains of Berkshire, Chester Whites, Cheshires, Poland Chinas, and Yorkshires. "In general no striking differences are observed in the rate of growth, or in the relation of the amount of food to growth, with these several breeds of swine. The daily rate of growth of our animals was, Cheshires, 1.23 pounds; Yorkshires, 1.14 pounds; Chester Whites, 1.08 pounds; Poland Chinas, 1.01 pounds; Berkshires, 1 pound. * * * Although the Berkshire pigs made the smallest gain they required the least food for each pound of growth, and the Cheshires making the largest gain, consumed the most food for each pound of increase of weight."

At the Michigan Agricultural College (*B. 4*) Poland China and Essex pigs were compared, with the result that the Poland Chinas made larger and more rapid gains than the Essex. In a later experiment (*B. 60*) Duroc-Jerseys, Berkshires, and Poland Chinas were compared in two separate trials (1888 and 1889). The Duroc-Jerseys made the largest gains both years. The Poland Chinas made the next largest gain in 1888, but the smallest gain in 1889. The cost of food per pound of gain was 4.67 and 4.65 cents for the Duroc-Jerseys, and 3.97 and 5.22 cents for the Berkshires, and 4.41 and 5.87 cents for the Poland Chinas. The results in this respect are so irregular as to lead to no definite conclusion. Berkshires, Chester Whites, and Yorkshires were compared at the Vermont Station (*B. 18*). The results of the comparison "showed but little difference, whatever difference there was being in favor of the Chester Whites." In another trial at the same station (*R. 1890, p. 114*) the Ches-

ter Whites grew the fastest, but they and the Poland Chinas ate the most food, so that the cost of food per pound of gain was slightly more than in the case of large Yorkshires.

Incidentally, the Massachusetts State Station (*R. 1890, p. 106*) noticed that the cost of food per pound of gain was a little smaller for the Chester Whites than for the Yorkshires. (*La. B. 8, 2d ser.; Minn. B. 14; Ontario Agl. Col. and Expt. Farms R. 1890.*)

Pigs, mange.—A disease caused by an animal parasite, *Sarcoptes suis*. The disease is trantmitted by contact. Blotches or small pustules appear on different parts of the body, and the hog scratches frequently. For treatment, wash the skin, and apply daily a mixture of one part of sulphur, one part of carbonate of potash, and eight parts of oil. Sulphur may be given in the feed. (*La. B. 10, 2d ser.*)

Pigweed.—See *Weeds*.

Pineapple (*Ananas sativa*).—Information regarding the culture of pineapples and their adaptability to portions of Florida is given in *Fla. B. 14*.

Pine trees (*Pinus* spp.).—Several kinds of pines, native and foreign, have been considered at the stations with a view to their forestry or ornamental value. In *Mich. B. 32* (being the report of a forestry convention) statistics are given with reference to the amount of white and red pine (*P. strobus* and *P. resinosa*) still remaining in the country, together with other information. In *Iowa B. 16*, both red and white pines are recommended for planting near home. The white pine is characterized by the Minnesota Station (*B. 24*) as "one of the most valuable and beautiful native evergreen trees we have." It is regarded as long lived, hardy, and of rapid growth in almost any soil or situation in the State when once established, except in the extreme western part, where it is unreliable. The red pine is said to rival the white for ornamental planting. The Scotch pine is recommended as a pioneer tree, but for permanent planting meets the objection that in that climate it appears to mature in about 20 years and then begins to look scrawny and bare.

The Austrian pine (*P. nigricans, P. austrica*) was open to the same objection as the Scotch, beside being much less hardy. The heavy-wooded or bull pine (*P. ponderosa*) is spoken of hopefully for the western prairies of the State. "It is the only pine found growing in the extremely dry climate of northwestern Nebraska and among the foot hills, where it is often found growing alone in exposed places." The dwarf Mugho pine (*P. mughus*) is noted as a very hardy and long-lived dwarf pine, seldom growing over 6 feet high; shrub-like in habit; very thick and bushy; desirable for ornamental planting and making a good wind-break. Fuller data concerning the *P. ponderosa* (also called yellow pine) are given in *Nebr. B. 18*.

Various notes on the Scotch and white pines as tested in that State occur in *S. Dak. B. 15, B. 20, B. 23, B. 29, R. 1888, p. 25.* "The hardiest of the evergreens seems to be the Scotch pine, and it is also the most rapid grower, at least while young;" on a gravelly knoll, however, a plantation was badly killed by a very dry autumn and open winter. *Kans. B. 10* is devoted to conifers considered with reference to fitness for ornamental planting in that State, and several pines are described in detail. "Next to the native red cedar, the conifers most certain to succeed in this locality are the Scotch and the Austrian pine," and between these it is found hard to decide. They are practically equal in hardiness; the chief objection to the Austrian pine is that it is too heavy and formal for most small gardens, its foliage in the winter assuming a hue the darkest of any evergreen except the red cedar;" in this regard, if any, the Scotch pine, which is brighter in color and in habit, has the advantage. These species are discussed with a good deal of fullness, as also the Table Mountain pine (*P. pungens*), the dwarf mountain pine (*P. mughus* and its var. *pumilio*), the pitch pine (*P. rigida*), the Southern yellow pine (*P. mitis*), and the white pine.

The hardiness of the white pine is questioned on account of its not infrequently dying after reaching the height of 10 or 15 feet, the leaves turning red, at first in

clusters, then throughout. The Table Mountain pine was hardy enough, but rather too picturesquely irregular for small grounds. The dwarf mountain pines were considered desirable in their sphere; the pitch pine is one of the least attractive of pines, but affords variety; the Southern yellow pine had done well, but as far as experience had gone did not seem to equal the Scotch and Austrian for general usefulness. *Ga. B. 2* and *B. 3* contain investigations of the fuel value of yellow pine (*P. mitis*) and Georgia pine (*P. palustris*). Full ash analyses of the wood are given also in case of the latter of the bark. For partial analyses see *Appendix, Table V.*

Fla. B. 12 contains analyses with regard to fertilizing ingredients of pine straw, bur and bark, for which see *Appendix, Table V.*

Pistacia trees (*Pistacia* spp.).—Two species have been tested in California (*R. 1885–'86, p. 117*).

"The *Pistacia vera*, or pistachio-nut tree, is a small tree of spreading habit of growth. The nut is known also as green almond, owing to the kernel having this exceptional color. They are eaten raw or roasted, while large quantities are used in candies. Our own experience, as well as the experience of others, shows this tree to be a very slow grower, although thriving better in the hotter part of the State." The largest plants observed, though several years old, were but 6 or 8 feet high.

The *Pistacia terebinthus* (the terebinth tree of the Orient) is a small tree of much quicker growth than the *P. vera*. It is a native of the Mediterranean region, yielding the fragrant Chio or Cyprian turpentine, which exudes from the tree. The tree has proved quite hardy in Berkeley, where in the garden of economic plants a large bush matured fruit. Owing to want of proper fertilization (of the flowers) the fruit dropped off early and no germ was found. The tree seems far better adapted to our climate than the *P. vera*."

Plane tree (*Platanus* spp.).—See *Sycamore*.

Plantain.—See *Weeds*.

Plant lice (*Aphididæ*).—This name is applied to numerous species of minute bugs infecting the leaves and tender parts of many plants. Some of the more common species are the apple aphis (*Aphis mali*), cherry aphis (*Myzus cerasi*), black peach aphis (*Aphis persicæ-niger*), peach louse (*Myzus persicæ*), grain louse (*Siphonophora avenæ*), currant plant louse (*Myzus rubi*), strawberry root louse (*Aphis forbesi*), cabbage aphis (*Aphis brassicæ*), willow grove louse (*Melanoxanthus salicti*), and woolly plant louse (*Aphis lanigera*).

They are all similar in size, being less than one-tenth of an inch long. Most of them are of a light-green color and for most of the season nearly all of them are wingless. They infest the leaves, stem, and roots of various trees and by sucking the sap do considerable injury. Their presence is the cause of numerous leaf galls and bent leaves, in the angles of which plant lice are secreted. The woolly plant lice, from their abundance, give a white color to the leaf or bark to which they are attached.

Toward autumn the eggs of plant lice are laid in protected crevices, by which they are carried over the winter. There are countless broods during the season and the progeny of a single individual in the course of a season if undisturbed would amount to millions. Happily there are numerous enemies to prevent their rapid spread. Among these are the lady-bird beetles, lace-wing flies, and syrphus flies. Where these do not hold the plant lice in check several well-known remedies will do so. The best of these is the kerosene emulsion sprayed over the plants. Strong soap suds, tobacco decoction, whale-oil soap, hot water, and arsenites are all good if thoroughly used. Cold water if sprayed forcibly will drive them from plants and if powdered tobacco be then dusted over the plants the lice will be kept away. White hellebore and pyrethrum (dry or in solution) may also be used.

(*Ark. R. 1889, p. 145, R. 1890, p. 70; Colo. B. 6; Del. B. 12; Ind. B. 25; Ky. B. 21, R. 1889, pp. 8 121; Me. R. 1888, p. 170; Mass. Hatch. B. 19; Mich. B. 50, B. 51;*

Nebr. B. 14; Nev. B. 11; N. J. B. 72, B. 86, R. 1890, pp. 484, 493, 497, 507; N. Mex. B. 2, B. 3; N. Y. State B. 35, n. ser.; N. C. B. 78; Ohio R. 1888, p. 157, B. Vol. II, 6, B. Vol. III, 4, and 11, B. Vol. IV, 2; Ore. B. 3, B. 5, B. 18; S. Dak. B. 13, B. 22; Vt. R. 1889, p. 157; W. Va. R. 1890, p. 157; Wyo. B. 2.)

Plaster.—See *Fertilizers.*

Plowing.—See also *Subsoiling.* At the Wisconsin Station (*R. 1891, p. 101*) plowed ground retained more water than unplowed, the difference amounting to 1.75 inches of rainfall.

At the Missouri and Utah Stations tests of the draft in plowing were made with a self-registering dynamometer. A deflection of the trace from a straight line between shoulder and doubletree gave a large increase of draft.

A truck or wheel under the end of the plow beam caused a saving of 14 per cent of the draft. Colters of every kind increased the draft. In a heavy loam or clay soil a furrow 7 inches by 14 inches required about three-horse power, or 450 pounds, to turn it.

Until the normal capacity of the plow was reached the draft, per unit of soil turned, decreased with width and depth of furrow.

Lengthening the hitch did not increase the draft. A share sharpened by a blacksmith drew harder than a dull one, which in turn drew harder than a sharp new share. A share perfectly straight on bottom and land side was drawn as easily as the usual form. When a sulky plow was forced to take land by adjusting the pole there was a loss of draft. The draft of walking and riding plows was not materially different.

A comparison at the Missouri Station (*B. 14*) of broad and narrow lap furrow plowing, ordinary plowing, and no plowing for corn were inconclusive. As between deep and shallow plowing, the results favored the latter. (*Mo. College B. 13, B. 32, and Mo. B. 14; Utah B. 2.*)

Plows.—See *Dynamometer tests of farm implements.*

Plum (*Prunus* spp.).—This fruit has been studied at many stations, with reference to varieties, methods of culture, and insect and fungus pests.

VARIETIES.—Tests are noted in *Ala. College B. 11, n. ser.; Ark. B. 17, R. 1888, p. 57, R. 1890, p. 46; Cal. R. 1882, p. 83, R. 1889, pp. 86, 108, 137, 183; Colo. R. 1888, pp. 83, 199, R. 1890, p. 117; Fla. B. 14; Ga. B. 11; Ill. B. 21; Ind. B. 10; La. B. 22, B. 26, B. 3, 2d ser., B. 8, 2d ser.; Me. R. 1889, p. 255, R. 1890, p. 140; Mass. Hatch B. 4; Mich. B. 55, B. 59, B. 67, B. 80; Minn. B. 5, B. 10, R. 1888, p. 284, R. 1890, p. 37; Mo. College B. 26, Mo. B. 10; Nev. R. 1890, p. 30; N. Y. State R. 1889, pp. 351, 356, R. 1890, p. 346; N. C. B. 72; N. Dak. B. 2; Pa. B. 18, R. 1888, p. 161; R. I. B. 7; S. Dak. B. 26; Tenn. B. vol. III, 5, B. vol. V, 1, R. 1888, p. 12; Tex. B. 8, B. 16; Vt. R. 1889, p. 157, R. 1890, p. 141; Va. B. 2.*

In *Mich. B. 80* the 81 varieties grown at the South Haven Substation are assigned to: *Prunus domestica* (the source of the ordinary European varieties), 42; *P. americana*, 14; *P. orientalis*, 10; *P. chicasa*, 3; *P. myrobolan*, 1; undetermined, 11.

N. Y. Cornell B. 38 is a monograph by Prof. Bailey upon native plums and cherries, containing a classification of species and derived varieties, with full descriptions and several figures. The varieties are divided into the Americana group (*P. americana*), 45 varieties; the wild-goose group (*P. hortulana*), 17 varieties; the Miner group, 10 anomalous varieties intermediate between *P. hortulana* and *P. americana*; the Chickasaw group *P. augustifolia* (*P. Chicasa*), 18 varieties; the Marianna group, with which is associated the De Caradeuc and doubtfully the Hattie, which are believed to be myrobalan or a hybrid between it and some American species; and the beach plum (*P. maritima*); besides these, hybrids and unclassified varieties. The relative merits of varieties are also considered, and the valuations of many varieties by eight growers in widely separated localities are presented in a table. Tables are also given obtained from a Maryland grower, showing dates of flowering

and of ripening for leading varieties, also their succession, on the Chesapeake peninsula.

Notes on native plums may also be found in *Minn. B. 5* and *S. Dak. B. 26*. The Rollingstone plum is described with figures of sections (*Minn. B. 10*). Several varieties of Japan plums have been grown with success at the southern stations. Of these the Kelsey is praised in *Fla. B. 14*, and this and the Botan are favorably reported in *La. B. 26*. Japan plums are noted as having done well at the California stations (*R. 1889, p. 184*). In the literature of the same station prunes, *i. e.*, plums suitable for drying, are separately listed. *Iowa B. 10* notes also that that State has at least two valuable varieties of prunes.

COMPOSITION.—An estimate of the fertilizing ingredients withdrawn from the soil by a crop of plums may be found in *Cal. B. 88*. The results of an investigation of both the physical and the chemical composition of prunes are reported in *Cal B. 97*. The ratio of flesh and stones and of juice in flesh are shown, and proximate and ash analyses for 12 samples given. For specimen analyses see *Appendix, Table III*. On the average the flesh amounted in weight to about 17 times the pits; and in the most juicy sample the flesh contained 87 per cent of juice.

In *Iowa B. 9* occurs a table showing the moisture percentages of six samples of green plums. In *Mass. R. 1891, p. 296*, analyses are given of two samples of plum-wood, healthy and diseased with black knot, from the same tree.

GRAFTING.—Stocks for grafting plums have been the object of investigation, reported in one case in *Iowa B. 10*. The myrobalan or cherry plum, extensively used in the East and West, had not been found hardy enough for the West. The black Damas and St. Julian had also proved worthless. Two varieties of the *P. Americana* are noted, one with small terminal branches, etc., and almost worthless small red fruit, the pits of which furnish poor stocks; and the typical form from which the fine cultivated varieties come, which is a "vigorous grower and the best stock obtainable for western use for the native and foreign varieties."

A general discussion of stocks is given in *N. Y. Cornell B. 38*. Reasons given by a Texas grower for preferring Marianna to peach stocks are quoted at some length.

At the Alabama Station the wild-goose plum was grafted on twelve stocks each of peach, seedling plum, and plum cuttings to compare with respect to longevity. After seven seasons, of those grafted on peach eight were living and healthy, on seedlings three, on cuttings one. See also *Cal. R. 1889, p. 108*.

The necessity of so planting plums that comparatively impotent varieties will be pollenized by others is considered in *N. Y. Cornell B. 38*. The usages advocated by different planters are noted.

Plum, black knot (*Plowrightia morbosa*).—This fungous disease, of native origin, attacks plums and cherries, both cultivated and wild, and is perhaps the worst enemy of these fruits. When mature, the black knot appears as a rough wart-like excrescence from the bark of twigs and branches and sometimes along the trunk itself.

The fungus grows just within the bark in the green layer, where its filaments may spread for sometime without an external manifestation of its presence. The first outward sign of the disease is a slight swelling under the bark either in the fall or during the growing season. The swelling increases until the bark is ruptured, and over the surface thus exposed the fungus rapidly sends threads for the formation of spores, giving it a velvet-like appearance. Other spores are formed, any of which, falling upon a suitable host, will spread the disease. The knot finally becomes black and more or less raised into small rounded divisions, each of which contains myriads of "winter" spores. These are matured late in the winter or early spring to extend the spread of the disease. The filaments of the fungus live from year to year in a tree once infected, the spores serving to spread it to new hosts and more rapidly over the old ones. Where the galls are few in number they may be thoroughly washed with kerosene, turpentine, copperas, sulphate of copper, and

other solutions with considerable effect, but when at all numerous they should be cut out in the fall and the cut places painted with some preparation to protect the wood. In all cases burn the portions cut away. The trees should be sprayed after the fall of the flowers with Bordeaux mixture, and two or three applications should be made during the season. While these means will aid in keeping the black knot in check, they will not avail much unless applied on wide areas, and all the wild plum and cherry trees in the neighborhood of orchards are rigidly destroyed, for the spores are often carried long distances by the wind. The addition of two ounces of Paris green to the formula for the Bordeaux mixture will aid in keeping off the curculio.

(*Conn. State B. 111; Mass. State R 1890, p. 200; N. J. B. 78, R. 1890, p. 364; N. Y. State B. 40, n. ser., R. 1890, p. 339; N. C. B. 76; Pa. B. 13, R. 1890, p. 166; Tenn. B. vol. IV, 1; Vt. R. 1890, p. 141.*)

Plum, brown rot (*Monilia fructigena*).—A fungous disease, attacking plums, cherries, apricots, peaches, and sometimes apples and pears. It is found as a spot disease on the leaves, and by the spreading and coalescence of spots will often involve a considerable portion of the leaf, causing its death. But it is usually most abundant and injurious on the fruit, especially of the plum and cherry. On the fruit it appears as a brownish, circular spot upon one side. This enlarges rapidly and soon the entire fruit becomes brown, shrunken, and soft. Finally it attacks the stalk to which the fruit is attached, and the fruit falls to the ground or, drying up, remains until the following spring, ready to spread the infection as soon as the host is provided. It is known that the spores in their development can force their filaments through the unbroken skin of the fruit where continued moisture is present. This condition is offered when the fruits are so abundant as to touch, thus preventing their drying off at the points of contact.

All diseased leaves and fruits should be burned, especially the old dried fruits, as it is largely through these that the disease is carried through the winter. Spraying with Bordeaux mixture, ammoniacal copper carbonate, or solution of sulphide of potassium (one-half ounce to a gallon of water) will be found beneficial if begun early enough. Washing the trees before blooming with 4 pounds of copperas in 6 gallons of water helps to destroy the spores. (*Conn. State B. 111; Ky. R. 1889, p. 31; Mass. State R. 1890, p. 213; Mich. B. 83; N. J. R. 1891, p. 305; N. C. B. 76.*)

Plum curculio (*Conotrachelus nenuphar*).—The adult is one of the snout beetles and is about one-fifth of an inch in length, of a grayish-brown or black color. It winters under rubbish and comes out in the spring as soon as the fruit is set, or earlier. It eats leaves, buds, and fruit. The female punctures the skin of the fruit with her snout, making a hole about a sixteenth of an inch deep. In this she deposits an egg, and in front of the hole cuts a crescent-shaped mark through the skin and thus prevents the crushing of the young larva by the growing fruit. The egg hatches in three to five (or more) days, and the small white worm eats its way about in the plum. The total number of eggs laid by one individual is fifty to one hundred, four or five per day. The presence of the curculio causes the fruit to secrete a kind of gum which escapes from the opening in which the egg was laid. The fruit usually falls about the time the grub is full grown, and it seeks the ground in which it burrows, to emerge in about a month transformed into a beetle. The curculio attacks other fruits, as the apple, peach, cherry, and nectarine, but prefers the plum.

It is more partial to some varieties than to others. Spraying the trees with a solution of Paris green (1 pound to 100 gallons of water) or with Bordeaux mixture, to which 2 ounces of Paris green is added, will kill many of the adult beetles. Spray before the flowers appear and ten days after. Jarring the trees will cause the beetles to fall to the ground, feigning death. If a sheet be spread on the ground and the tree strongly jarred many may be caught. This must be done early in the morning or late in the evening. By placing chips about the tree under which the curcu-

lios collect, many may be caught and killed. Throwing them into water to which a little kerosene has been added is the easiest way of killing them when caught.

(*Ind. B. 25, B. 33; Iowa B. 5, B. 9; Ky. B. 40; Mass. Hatch. B. 10, B. 12; Mich. B. 66, R. 1889, p. 260, (B. 53), Miss. B. 14; N. J. B. 86, R. 1889, p. 296, N. Y. Cornell B. 3; N. Y. State B. 35, n. ser.; N. C. B. 78; Ohio B. Vol. II, 1 and 6, Vol. III, 4 and 11, Vol. IV, 2, R. 1888, p. 146; R. I. B. 15; W. Va. R. 1890, p. 151.*

Plum, shot-hole fungus (*Septoria cerasina*).—A disease due to a fungus which causes small round holes in the leaves of plum, peach, and cherry trees. Rather early in the season numerous spots appear on the leaves. The tissue lying between these spots dries up and finally falls out, leaving a clean-cut hole. The spread of the disease so weakens the leaves that they drop from the tree, leaving it bare early in the season. Of course the fruit is injuriously affected by such processes.

A spray of Bordeaux mixture applied just after the fall of the flowers and repeated every two weeks for three or four applications will be beneficial. (*Ohio B. Vol. IV, 9.*)

Poland China pigs.—See *Pigs, breeds.*

Pomegranate (*Punica granatum*).—Tests of this fruit have been begun at several stations (*Cal. B. 1888-'89, pp. 110, 197; La. B. 3, 2d ser.; N. Mex. B. 2; Tex. B. 8*).

Pop corn (*Zea mays* var.).—See also *Corn.* Variety tests of pop corn are reported in *Ill. B. 13; Nebr. B. 12, B. 19; N. Y. Cornell B. 16; N. Y. State R. 1883, p. 50, R, 1884, p. 183; Vt. R. 1889, p. 134.* In *N. Y. State R. 1883* three types are recognized, viz, pop corn proper, resembling flint but smaller; pearl pop corn with rounded kernels, and rice pop corn with pointed kernels. A "golden pop" with extremely small ears approaching the rice type is also noted. Data are given of the growth of many varieties planted and a description of the crop, which was very much mixed. In *N. Y. State R. 1884*, 10 typical varieties, classified according to size and form of ear-stalk, color of cob, etc., are described. In *Ill. B. 13*, 14 varieties are fully described. Two general classes are recognized, viz, *rice* corn with pointed kernels and the varieties with rounded or flattened kernels, including that known as pearl corn.

Analyses of pop corn stalks and ears, considered as a feeding stuff, are recorded in *Ga. B. 12; N. Y. Cornell B. 16.* (See *Appendix, Table I.*)

Poplar trees (*Populus* spp.)—Besides the native *P. monilifera*, the cottonwood (which see), several European, especially Russian, poplars have been put on trial in the northern prairie States, where hardy and rapid-growing trees are much needed.

An illustrated description of twelve species and varieties is presented in *Minn. B. 9*, and several of these are further noted in *B. 24.* Notes on various poplars planted at the South Dakota Station may be found in *B. 12, B. 15, B. 20, B. 23, B. 29, R. 1888, pp. 25, 27.*

Brief notes on several species occur in an Iowa bulletin of 1885, and a short list with record of growth is given in *Colo. R. 1889, p. 24.*

The silver or white poplar is represented by the Minnesota Station as having a valuable wood and as desirable as a forest tree, though its sprouting from the roots makes it objectionable as a lawn or street tree. Different forms of Lombardy poplar are described, but not recommended for extensive planting. Of the Russian poplars, the *P. certinensis* is the most highly esteemed both here and at the South Dakota Station. It is a fast-growing, hardy tree of erect habit, having broadly oval, pointed leaves, which are thick and leathery.

Its foliage and that of others of the class is regarded as more healthy than that of the cottonwood, though according to *S. Dak. B. 23* it is subject to the attacks of the cottonwood leaf beetle.

P. alba, var. *bolleana*, is praised for ornamental planting. It has the upright and close habit of the Lombardy poplar, but promises to be long-lived, is perfectly hardy, and does not sucker. Its foliage is silvered like that of the white poplar, but is somewhat differently cut. Other species more or less approved in *Minn. B. 24* are:

P. petrouski, which appeared, as there received, to be identical with the *certinensis; P. balsamifera* var. *laurifolia*, laurel-leafed poplar, a little slower grower than *P. certinensis*, with thick healthy foliage, white on the under side, distinct and desirable; var. *Siberica pyramidalis* of the same; *P. wobsky*, a poplar of peculiar aspect, resembling a cherry tree in foliage; *P. betulifolia*, birch-leafed poplar, not of special value, but suitable to give variety to timber borders.

Successful experiments in growing Russian poplars from hard-wood cuttings are reported in *Minn. R. 1888, p. 223 (B. 5), B. 9.* The method followed is described and directions for planting are given. A similar effort at the South Dakota Station was successful save for the interference of cutworms (*R. 1889, p. 35*). At the same station (i' id.) scions of white poplar and var. *bolleana* were grafted upon cottonwood stocks, with results as noted under *Cottonwood.*

Potash.—See also *Fertilizers.* All plants require potash. Clay soils are frequently supplied with this element in sufficient quantity, while sandy soils are more apt to be deficient in this respect.

The chief sources of the potash of commercial fertilizers are ashes and various potash salts mined in Germany. These are carnallite, a raw product not offered in the American market; kieserite and sylvinite, not in general use in America; kainit, which consists of the sulphates and chlorides of potassium, sodium, and magnesium, and which is widely used; sulphate of potash and magnesia (double manure salt); sulphate of potash, nearly twice as rich in potash as the preceding; muriate of potash, the most soluble of the potash salts; and calcined potash, less concentrated than the two preceding salts. For composition of above salts see *Appendix, Table IV.*

Kainit renders the soil more compact and retentive of moisture. Kainit and other crude salts, also the concentrated salts that contain chlorides, should not be applied to tobacco, since the chlorine injures the burning quality. The sulphates are preferred for tobacco, potatoes, and sugar beets.

Potassic fertilizers were profitable on Irish potatoes in Kentucky and in Massachusetts, giving in the latter State an average increase of 41.5 bushels per acre. (*Mass. Hatch. B. 18.*) In New Jersey (*B. 80*) muriate of potash proved very slightly better for potatoes than sulphate of potash and kainit; at the Massachusetts State Station (*R. 1888, p. 123*) the sulphate gave slightly the best result.

In New Jersey potash proved highly profitable on sweet potatoes and on sorghum, increasing the total weight of sorghum and the product of sugar.

In Kentucky the chloride and sulphate of potash were equally effective on hemp; 160 pounds of either, with nitrogen, proved sufficient (*Ky. B. 27*).

On corn in New Jersey and in New England, potash has generally given excellent results. One experiment in New Jersey showed an increase of 30 bushels per acre. In others both stover and grain were increased, the former more notably than the grain. In Massachusetts many experiments gave an average increase of 11.3 bushels of corn and 1,308 pounds of stover, due to potash fertilization (*Mass. Hatch. B. 14*). In Kentucky potash was profitable on corn, and its beneficial results extended to the crop of succeeding years (*Ky. B. 17, B. 26*).

Eighty experiments on corn conducted under Prof. Atwater's direction during 1878–'81 resulted in a marked increase due to potash in 12 cases; a more or less marked increase in 24 cases; and no gain in 44 instances. (*Conn. Storrs R. 1888, p. 92*). In South Carolina, on corn potash gave little or no increase (*R. 1888, p. 158, 165*).

At the New York State Station (*R. 1888, p. 348*) a potassic fertilizer on oats produced no effect. In South Carolina potash on grain proved unprofitable (*R. 1888, p. 158*).

Potash was needed by tobacco in Kentucky (*B. 28*). (See *Tobacco.*) On sugar cane in Louisiana it was unprofitable (*La. B. 20*).

At the North Louisiana Station (*B. 16, n. ser.*) the yield of cotton was not materially changed by any form of potash. In South Carolina potash was less needed by cotton than were phosphoric acid and nitrogen (*R. 1888, p. 246*). On the yellow

loam lands of Mississippi potash is demanded by the cotton plant (*B. 24*). At the Alabama College Station (*B. 36, B. 41*) kainit checked the yellow leaf blight of cotton.

For the effect of potassic fertilizers on injurious insects see *Fertilizers*.

(*Conn. State R. 1889, p. 226; Ind. B. 33; Mass. Hatch. B. 9, Special B., May, 1890, B. 13; Me. R. 1888, p. 29; N. Y. Cornell B. 33; N. J. B. 54, R. 1888, p. 44; Ohio B. Vol. II 5; Vt. B. 15.*)

Potassium sulphide.—See *Fungicides*.

Potato (*Solanum tuberosum*).—The useful product of this plant is the underground tubers, which are thickened stems, having their cells mostly filled with starch as a reserve food for the new plant. The "eyes" are compound buds, each of which may produce one or more stalks. The skin is formed of a layer of delicate cork cells, some of which are loosely arranged so as to permit the passage of air. The fibrous framework and the pith of the stalk are continued into the tuber.

An illustrated description of the structure of the potato tuber was published in *Ind. B. 15*.

VARIETIES.—Tests of varieties have been reported from stations in Alabama (College and Canebrake), Arkansas, Colorado, Delaware, Florida, Georgia, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts (Hatch), Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New York (State), Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, and Wisconsin. Among the varieties which have been most productive in different localities are the following:

Alexander.	Early Maine.	New Giant.
American Giant.	Early Ohio.	New Queen.
Beauty of Hebron.	Early Oxford.	Polaris.
Bliss's Triumph.	Early Puritan.	Red Elephant.
Burbank.	Early Rose.	Rural Blush.
Burbank Seedling.	Early Sunrise.	Rural New Yorker No. 2.
Chicago Market.	Empire State.	Seneca Beauty.
Dakota Red.	Governor Rusk.	Snowflake.
Delaware.	Grange.	Summit.
Dictator.	Green Mountain.	Thorburn.
Early King.	Howe Premium.	White Elephant.

Experiments with reference to the improvement of wild varieties of potatoes have been made at several stations (*N. Y. State R. 1885, p. 216, R. 1886, p. 147; Pa. B. 7, R. 1886, p. 284*). The Michigan Station (*B. 70*) reports that after several years' trial the wild Mexican variety has gradually increased in size and yield, but is too coarse to be valuable. *Solanum jamesii* has shown no increase in size.

(*Ala. College B. 7 (1889); Ala. Canebrake B. 6; Ark. R. 1888, p. 59, R. 1889, p. 27; Colo. B. 4, B. 7, R. 1889, p. 104, R. 1890, p. 194; Del. R. 1890, p. 106; Fla. B. 11; Ga. B. 8, B. 17; Ind. B. 18, B. 31, B. 34, B. 38; Iowa B. 16; Kans. R. 1888, p. 226, R. 1889, p. 168; Ky. B. 9, B. 16, B. 22, B. 37; La. B. 11, 2d ser., B. 16, 2d ser., B. 27, 2d ser., B. 4, 2d ser.; Me. B. 18 (1887), R. 1888, p. 123, R. 1889, p. 146; Md. R. 1888, p. 59, R. 1889, p. 51, R. 1890, p. 108; Mass. Hatch B. 7; Mich. B. 13, B. 34, B. 46, B. 57, B. 60, B. 70, B. 85; Minn. B. 1, B. 5, R. 1888, pp. 82, 230; Mo. B. 10, B. 13, B. 16; Nebr. B. 6, R. 12, B. 19; Nev. B. 14, R. 1890; N. Y. State B. 69 (1883), B. 11, n. ser., B. 13, n. ser., R. 1884, p. 293, R. 1885, p. 194, R. 1886, p. 140, R. 1887, p. 76, R. 1888, p. 158, R. 1891, p. 480; Ohio B. vol. III, 1, R. 1888, p. 116; Ore. B. 4, B. 11; Pa. B. 6, B. 10, R. 1888, p. 41, R. 1889, p. 28, R. 1890, p. 152; R. I. B. 5 (R. 1889, p. 97), R. 1890, p. 122; S. Dak. B. 2, R. 1890, p. 14; Tenn. B., vol. III, 1; Utah B. 14; Vt. R. 1889, p. 117, R. 1890, p. 163; Va. B. 6, B. 8, B. 11; Wis. B. 9, B. 11, B. 13, B. 17, B. 22, R. 1890, pp. 205, 268, R. 1891, p. 135.*)

COMPOSITION.—See *Appendix, Tables I and II.* Among recent determiatinons of the starch content of potatoes are the following:

At Colorado Station (*B. 7*) 126 named varieties averaged 17.17 per cent and 94 seed-

ling varieties 18.85 per cent; at Massachusetts Hatch Station (*B. 18*) potatoes grown with different fertilizers averaged 16.02 per cent, but muriate of potash reduced the starch content; at Nevada Station (*B. 14*) the starch in 52 varieties varied from 12.32 to 23.03 and was over 15 per cent in 37 varieties; at Utah Station (*B. 5*) a relatively large starch content was found. The New Jersey Station (*B. 80, B. P, R. 1890, p. 120, R. 1891, p. 121*) reports experiments with different fertilizers, in which the fertilizers, particularly potash, seemed to reduce the starch content. Sulphate of potash had the least effect. The Iowa Station (*B. 12*) found a relatively large amount of albuminoids in the "seed" ends.

SEED.—Experiments in planting large and small whole tubers and cuttings of various sizes have been made at more than twenty stations in different parts of the country. In some cases these experiments have been continued several years. While there has been great variety in the details of the results, there have been only a few instances in which the total yield did not increase with the amount of seed used. Whole tubers have given larger yields than cuttings and large tubers than small. The marketable product has increased with the size of the cutting or tuber, but at a smaller rate than the total yield. The largest portion of this gain has been in small potatoes. In most cases the net gain of merchantable product over seed has not been sufficient to make the planting of whole tubers profitable. The vines from whole tubers grow more vigorously and the crop has a tendency to mature earlier than that from cuttings. In ordinary practice it will usually give the best results to plant good-sized, well matured, and healthy potatoes, cut to two or three eyes. (*Ala. College B. 31; Colo. B. 4, B. 7; Ind. B. 31, B. 34, B. 38; Ky. B. 9, B. 16, B 22; La. B. 4, 2d ser., B. 16, 2d ser.; Md. R. 1888, p. 59, R. 1889, p. 51, R. 1890, p. 108; Mass. State R. 1884, p. 87, R. 1886, p. 82, R. 1887, p. 141; Mich. B. 13, B. 34, B. 46, B. 85; Minn. B. 1; Mo. College B. 12; N. Y. State R. 1883, R, 1884, p. 68, R, 1885, p. 47; R. 1886, p. 149, R. 1887, p. 86, R. 1888, p. 158, R. 1889, p. 223, R. 1890, p. 372; N. Y. Cornell R. 1879, R. 1880, R. 1883, R. 1885; Ohio B. vol. III, 1, R. 1882, p. 53, R. 1883, p. 92, R. 1884, p. 91, R. 1885, p. 70, R. 1886, p. 154; Ore. B. 11; Pa. R. 1886, p. 131; R. I. B. 5 (R. 1889, p. 97), R. 1890, p. 109; Tenn. B. vol. III, 1; Utah B. 5, B. 14; Vt. B. 13, R. 1888, p. 97; Va. B. 8; W. Va. B. 20; Wis. B. 22, R. 1883, p. 21, R. 1890, pp. 205, 268, R. 1891, p. 135.*)

Experiments and observations on the relation of the number of eyes on the seed tuber to the product, at the Indiana Station (*B. 42*), indicated that the weight of the cutting is more important than the number of eyes, *i. e.*, the heavier the piece the larger the yield.

In 1882 it was shown at the New York State Station (*B. 18*) that single eyes cut deep would give larger yields than if cut shallow.

In experiments in which the "seed" ends of tubers have been compared with the "stem" ends for seed the results as a rule have favored the seed ends. (*Colo. B. 4; Ind. B. 38; Md. R. 1888, p. 59; Mich. B. 85; Minn. R. 1888, p. 82; Mo. B. 12; N. Y. State B. 28 (1883), B. 64 (1883), R. 1884, p. 68; Utah B. 14.*) The practice of cutting off the seed ends before planting is not to be recommended (*N. Y. State R. 1888, p. 168, R. 1889, p. 223; Wis. B. 22, R. 1891, p. 135*).

Several experiments have indicated that drying the pieces of seed potatoes for a few days between cutting and planting may somewhat increase the yield (*Md. R. 1888, p. 59; N. Y. State R. 1886, p. 151, R. 1887, p. 87; Ohio R. 1888, p. 116*).

Dipping the cut surfaces of seed potatoes in plaster had no good effect on the yield (*Wis. B. 22*).

Potatoes grown in Maryland and Vermont were planted at the stations in both these States in 1889 and 1890. The largest yields at both stations were produced by the Vermont seed. Seed from Michigan, Wisconsin, and Vermont planted at the Missouri Station produced larger yields than the home-grown seed, but there were important differences in the yields from the seed grown in the several Northern States. At the Colorado Station the results from Eastern and Western seed were

about alike. Tests at the New York Cornell Station led to the conclusion that careful selection of the stock to be used for seed is of more importance than changes in latitude. (*Colo. B. 7; Md. R. 1889, p. 56, R. 1890, p. 108; Mo. B. 15; N. Y. Cornell B. 25; Vt. R. 1889, p. 143, R. 1890, p. 181.*)

A series of experiments at the New York State Station indicated that seed potatoes selected from the most productive hills gave relatively larger yields. (*N. Y. State B. 108, B. 109, R. 1885, p. 204, R. 1887, p. 82.*)

The Kansas Station (*B. 19*) reports an experiment indicating that where two crops of potatoes are grown the same season seed potatoes selected from the second crop produce more and larger tubers, but that there is no gain in earliness.

CULTURE.—The experiments in the culture of potatoes thus far made by the stations have been so conflicting in their results as to indicate that more depends on the climate, soil, and other conditions under which the crop is grown than on the particular method of culture employed.

At the Michigan Station (*B. 57, B. 70*) shallow planting (1 to 2 inches deep gave the best results, but at the Minnesota Station (*B. 10*) in a dry season the seed covered with 8 inches of earth produced the largest yields. At the Utah Station (*B. 5*), where irrigation was used, differences in depth of planting did not materially affect the yield. Planting in trenches is favored in the following reports: *Ark. R. 1889, p. 27; Mich. B. 57; Va. B. 8.* At the Kentucky Station (*B. 22*) the trench system had no advantage, and at the Indiana Station (*B. 34*) planting in hills gave better results. At the Wisconsin station little difference in results has been found between planting in hills and in drills (*Wis. R. 1890, p. 211, R. 1891, p. 135*). The yields from planting at different distances have varied with the amount and kind of seed used and the method of culture (*Ky. B. 22; Mich. B. 70, B. 85; R. I. B. 5* (*R. 1889, p. 97*), *R. 1890, p. 109; Utah B. 5; Va. B. 8*).

(See also *Ala. College B. 31; Ala. Canebrake B. 6; Ind. B. 38; Minn. B. 5; N. Y. State R. 1888, p. 158, R. 1889, p. 223; S. Dak. R. 1890, p. 141; Utah B. 14.*)

SECOND CROP.—In the Southern States the practice of growing a second crop of potatoes is extending. The North Carolina Station has recently published a bulletin of information on this subject (*N. C. B. 85*), in which attention is called to the fact that, whereas it was formerly the practice to plant potatoes kept over from the previous year, it is now becoming customary to use potatoes of the early crop of the same year as seed for the late crop. The Early Rose variety is largely used for the second crop. The Mississippi Station reports successful experiments in raising a second crop (*Miss. R. 1890, p. 37, R. 1891, p. 31*). In Kansas in 1890 a second crop was grown when the earlier planting entirely failed (*Kans. B. 19*).

FERTILIZERS.—Numerous experiments with different kinds and combinations of fertilizers for potatoes have indicated that as a rule the best results are obtained when the fertilizer contains phosphoric acid, potash, and nitrogen. The desirable amount and form of each ingredient will vary with the kind of soil.

After making tests of various fertilizers on different kinds of soil, the Ohio Station (*B. vol. III, 1*) drew the following conclusions, which agree substantially with those reported for potatoes in a bulletin of this Department on Results of Field Experiments with Various Fertilizers, published in 1883:

"(1) Sulphate of potash and muriate of potash have in some instances increased the yield, but in no case sufficiently to make their use profitable.

"(2) Nitrate of soda and sulphate of ammonia have in a few cases given a slight increase in yield, but not to a profitable degree.

"In seasons when blight has been the most severe these substances, especially the former, have apparently exerted an injurious effect.

"(3) Superphosphate (dissolved bone-black), acid phosphate, and Thomas slag have in nearly all cases increased the yield. Thomas slag is the cheapest form in which phosphoric acid can be obtained, and the trials indicate that its use on potatoes is likely to be attended with greater profit than that of either of the other substances named.

"(4) A mixture of sulphate of potash, superphosphate, and nitrate of soda has usually given better results than superphosphate alone, but not always.

"(5) Barnyard manure has increased the yield, but not always the total marketable product, because of the usual prevalence of scab where this fertilizer is used.

"(6) In no case has the potato crop been benefited, to a profitable degree, by the application of fertilizers of any kind on soil that was already in a high state of fertility.

"(7) On soil that had been worn by previous cropping, phosphatic fertilizers, the so-called complete chemical fertilizers, and barnyard manure have in nearly all cases given profitable returns.

"(8) The rational conclusion is that since the potato requires a soil that is in a high state of fertility, and since the direct application of fertilizers to the crop is attended with considerable uncertainty, the most feasible method is to bring the soil up to the proper condition by enriching the land for previous crops. The best crop of potatoes that has been grown at the station succeeded a crop of cabbages that had been heavily manured. The most approved practice is to grow potatoes after clover, fertilizing both the clover and preceding crop."

Eleven brands of fertilizers designed especially for potatoes were examined by the Connecticut State Station (*B. 104*) in 1890. It was found that they contained percentages of nitrogen ranging from 2 to 5.3, phosphoric acid from 7.7 to 11.2, and potash from 4.2 to 10 per cent. While any one of them might be an excellent genera- fertilizer, none was preëminently adapted to the special needs of the potato crop.

(Ala. College B. 31; Ala. Canebrake B. 6; Ark. R. 1888, p. 59, R. 1890, p. 9; Colo. B. 4; Conn. State R. 1888, p. 119, R. 1889, p. 203; Fla. B. 13; Ga. B. 8, B. 17; Ind. B. 31, B. 38; Ky. B. 9, B. 16, B. 22, B. 37; La. B. 27, B. 4, 2d ser., B. 16, 2d ser.; Me. R. 1889, p. 146, R. 1890, p. 96; Mass. Hatch B. 17; Mich. B. 57, B. 70, B. 85; Minn. R. 1888, p. 137; N. H. B. 12; N. J. B. 80, B. P. R. 1890, p. 120, R. 1891, p. 108; N. Y. State R. 1888, p. 158, R. 1889, p. 247, R. 1890, p. 372; Ore. B. 11; Pa. R. 1886, p. 13; R. I. R. 1890, p. 23; Vt. B. 13, R. 1888, p. 93; Va. B. 8; W. Va. B. 20.)

Potato beetle, Colorado (*Doryphora decem-lineata*).—This well-known beetle was first brought to notice in 1859 and by 1874 had overrun most of the country. There are usually three broods each season, the adults of the last brood passing the winter under rubbish or in the earth. The female lays about a thousand eggs in clusters on the leaves of the potato as well as on adjoining plants. These hatch in about a week and the larvæ attain their growth in about fifteen days, after which they are transformed into the adult beetle. Both adult and larva feed upon the potato plant, and on this account they may be easily treated. Dusting the plants with Paris green or London purple mixed with flour or plaster, and spraying them with the same in the proportion of 1 ounce to 6 or 8 gallons of water will rid the plants of this pest. Especial care should be taken with the early brood, as they increase so enormously. Kerosene emulsion and a solution of arsenite of ammonia are also recommended. Hand picking the bugs and crushing all eggs will be found advantageous if the potato patch is small and no spraying apparatus is available.

(Del. B. 4; Ind. B. 34; Ky. B. 40; La. B. 4, 2d ser.; N. Y. State, R. 1888, p. 149, R. 1889, p. 224; N. C. B. 78; Ohio B. vol. II, 1; S. C. R. 1888, p. 40; S. Dak. B. 13; W. Va. R. 1890, p. 155.)

Potato rot (*Phytophthora infestans*).—A disease caused by the presence of the above-named fungus in the tuber. The filaments of the fungus, having gained access to the tuber, spread rapidly, filling the cells and robbing them of their substance. This will result in "dry rot," unless there is considerable moisture present when the ordinary processes of decay come in, and the "wet rot" is the result. The "blight" of potatoes is generally supposed to be caused by this same fungus, although some investigators think it is caused by bacteria. It affects the leaves and stalks, causing them to die prematurely, and consequently reducing the crop of fully-developed tubers. The fungus is said to be unable to pass the winter in the old stalks or

ground, but must be spread through the already infested seed potatoes. It is wel known that the fungus continues growing even after the crop has been dug and stored. Heating the tubers to about 105° will kill the fungus, but not injure potatoes for seed. They must be kept at this temperature for from four to six hours. Spraying the seed with Bordeaux mixture is known to give excellent results.

(*Conn. State B. 105, 111, R. 1890, p. 102; La. B. 4, 2d ser.; Mass. Hatch B. 11; Mass State R. 1890, p. 223; N. J. R. 1890, p. 345, B. G; Ohio B. vol. II, 6, vol. III, 8; R. I. B. 14, R. 1890, p. 137; Vt. B. 24, R. 1890, p. 136.*)

Potato scab (*Oöspora scabies*).—This disease, which has been attributed to quite a number of causes, is now considered to be due to a fungus. The appearance of the potato affected is well known. The thick brown scabs or patches formed are made by the potato in trying to heal the wound caused by the attack of the fungus. This disease has been proved identical with that described in the article on *Beet scab*. The treatment is the same in both cases.

(*Conn. State R. 1890, p. 81; Ill. R. 1888; Me. R. 1890, p. 115; N. Dak. B. 4; N. J. R. 1890, p. 347, R. 1891, p. 307; R. I. B. 14.*)

Poudrette.—A manure prepared from night-soil dried and mixed with charcoal, gypsum, etc. For composition see *Appendix, Table IV.*

Poultry.—For notes on different breeds, see *La. B. 26, B. 8, 2d ser., B. 16, 2d ser.*

NITROGENOUS VS. CARBONACEOUS FOOD FOR POULTRY.—At the New York State Station (*B. 29, R. 1889, p. 56*) two lots of pullets of six different breeds were fed during the laying season on corn on the cob, oats, meat scraps, and grass. In addition, one lot received a mixture of wheat bran, linseed meal, and ground oats, and the other lot corn meal. The larger breeds did somewhat better with the first or more nitrogenous food; the smaller breeds produced more eggs with the more carbonaceous ration (corn meal.) The year's manure of the lot fed corn meal was valued at 10 cents per fowl; that of the other lot at 14 cents.

In a second experiment the number and weight of the eggs were larger with the corn-meal ration than with the more nitrogenous mixture. The latter diet, however, kept the birds in better health and plumage.

At the New York Cornell Station (*R. 1890, p. 162*) one lot of fowls was fed on a mixture of wheat shorts, cotton-seed meal, and skim milk, and another lot on cracked corn and corn dough. The results agree with those above in that the eggs produced by the carbonaceous food (corn) were larger. The lot fed on corn laid only twenty-six eggs, while the other lot laid seventy-nine.

The eggs produced by the nitrogenous ration were of a disagreeable flavor and smell, had a small yolk, and kept poorly. At the same time and place a pen of chickens about six weeks old was fed on the nitrogenous mixture used in the other experiment and another similar lot on the carbonaceous ration. The former lot about doubled in weight, while the other corn-fed chickens added less than 40 per cent to their weight. Those fed on the nitrogenous diet were healthy and well feathered, while the others were sickly and in several cases almost destitute of feathers. The flesh produced by the nitrogenous food was darker, more succulent, tenderer, and contained a larger proportion of albuminoids and a smaller proportion of fat than the flesh of the corn-fed lot.

OYSTER SHELLS, TALLOW, AND SALT FOR POULTRY—At the New York State Station (*B. 38, n. ser.*) hens which were allowed access to coarsely ground oyster shells laid more eggs than hens that received ground glass. The egg shells of those eating oyster shells were also heavier. When oyster shells were fed a pound of eggs was produced for every 3.95 pounds of water-free food. The amount of ground glass consumed was large, being between a third and a fourth of the water-free food.

At the same station (*B. 39*) hens were fed all the tallow which they would readily eat along with their usual food. There were no injurious effects on health except that the hens having a large amount of fat in their diet were later in moulting than the others.

SALT was not found injurious to hens till the quantity was increased to about half a pint a day for one hundred hens, when a few cases of diarrhea occurred.

AMOUNT OF FOOD FOR LAYING HENS.—In a six months' experiment at the New York State Station (*B. 29*) each bird of the smaller breeds daily consumed an average of 2.56 ounces of food (mostly corn meal and wheat); the larger breeds ate 3.6 ounces.

COST OF FOOD FOR GROWING CHICKENS.—With skim milk at 25 cents per hundred pounds a mixture of corn meal, bran, middlings, and linseed meal at $20 per ton, green clover at $2 per ton, and meat scraps at 2½ cents per pound it cost at the New York State Station (*R. 1891, p. 189*) approximately 5½ cents for each pound of gain made by growing chickens. These chickens at ten and a half weeks old averaged 2.4 pounds in weight.

At the Maine Station (*R. 1887, p. 101*) the gain made by twenty-four cockerels in thirty-two days was 20½ pounds, worth $2.50. The food consumed was 94 pounds of corn and 12½ pounds of meat scrap and blood, the whole costing $1.50.

At the New York State Station (*R. 1889, p. 63, R. 1890, p. 122*) the weight of water-free food required to produce an ounce of gain on cockerels and capons was 11.35 ounces. Each fowl produced about 43 pounds of manure in a year, of which about two-thirds was moisture.

RATE OF GROWTH OF CHICKENS AND DUCKS.—The New York State Station (*R. 1890, p. 138*) used home-made incubators and brooders for chickens and ducks. When 12 weeks old a lot of White Plymouth Rock chicks averaged 1.7 pounds apiece, while Pekin ducks, also reared in a brooder, at the same age weighed nearly 4 pounds.

CAPONIZING.—The New York State Station during 1890 lost no fowls from caponizing; it is stated that the frequent fatality of this operation is not necessary if a bright day is selected and if the birds have fasted. The operation should be performed a few weeks after the time when the sex can be distinguished.

KEEPING EGGS.—The New York State Station (*R. 1888, p. 59, R. 1890, p. 122*) preserved eggs four or five months without loss by the following method: The eggs were first wiped with vaseline to which salicylic acid had been added and then packed in salt. The boxes of eggs were turned every two days. At the end of four months these eggs were superior in quality to limed eggs. There was little difference in the keeping of fertile and infertile eggs. Eggs were found to lose about 5 per cent in weight when kept in the air for a month. The specific gravity, which with fresh eggs varied between 1.072 and 1.104, diminished with age, but the experimenter concluded that a specific-gravity test could not determine the freshness of eggs.

At the New York Cornell Station (*B. 37*) the losses were practically identical when eggs were packed in salt, in lime water and brine, and in Richter's mineral preparation. A little less than 5 per cent spoiled between September 9 and January 21.

POULTRY HOUSE.—A description and plan of a poultry house built at the New York State Station are given in *N. Y. State R. 1889, p. 65.*

Prickly comfrey. (*Symphytum asperrimum*).—A rank-growing, succulent, perennial plant grown for forage. Until accustomed to it cattle do not relish prickly comfrey. At the New York State Station hogs did not thrive on it. Though seeds are produced this plant is generally propagated by root cuttings, placed at distances of 2 or 3 feet.

At the North Carolina Station (*B. 73*) prickly comfrey grew well, but became infested with caterpillars. Considerable labor is required in harvesting this crop, since each hill must be cut separately.

At the Wisconsin Station (*R. 1889, p. 207*) the second year's growth of prickly comfrey was cut four times, yielding at the rate of nearly 34 tons per acre, while red clover yielded at the rate of 26 tons of green fodder. Analyses of both plants are given and the conclusion is reached that prickly comfrey can not compare in value as a cattle food with red clover.

At the New York State Station (*R. 1888, p. 332*) it proved a valuable soiling plant, but unsuited for hay and silage.

See also *Iowa B. 11; N. Y. State B. 22, R. 1887, p. 72, R. 1889, p. 93; Pa. R. 1888, p. 43; S. C. R. 1888, p. 133; Vt. R. 1888, p. 77; Wis. R. 1888, p. 138.*

Privet (*Ligustrum* spp.).—The common privet (*L. vulgare*) is noted in *Iowa B. (1886), B. 16,* and *Minn. B. 24* as too tender for those regions, though recently introduced Polish and central Russian forms are hardy. The California privet (*L. ovalifolium*), not hardy in Minnesota, is a favorite plant for hedges and wind-breaks in Texas (*B. 8*).

Protein.—See *Foods.*

Prune.—See *Plum.*

Pumpkin (*Cucurbita* spp.).—Tests of varieties are recorded in *Colo. R. 1889, pp. 41, 122, R. 1890, pp. 194, 210; Md. R. 1889, p. 62; Minn. R. 1888, pp. 253, 261; Nebr. B. 12; N. Y. State R. 1885, p. 193, R. 1886, p 241, R. 1887, p. 324.*

In *N. Y. State R. 1887. p. 243,* a classification of squashes and pumpkins is given according to species and varieties. Of the whole number fifteen are denominated pumpkins, and these are referred in part each to *C. pepo, C. maxima,* and *C. moschata.* All are fully described, English and foreign synonyms are given, and the names indexed.

At the New York Cornell Station (*B. 25*) in experiments in herbaceous grafting pumpkin vines were found to unite with squash. (See *Squash.*)

Germination tests of pumpkin seed are recorded in *N. Y. State R. 1883, p. 70; Ohio R. 1884, p. 197, R. 1886, p. 254; Ore. B. 2; Vt. R. 1889, p. 108.*

Purslane.—A test of three cultivated varieties is reported in *N. Y. State R. 1885, p. 192.* "These are garden varieties of the common purslane *Portulaca oleracea,* and are grown in France as vegetables, the foliage being eaten both raw and cooked. The varieties appeared quite distinct, and all were more vigorous and succulent than the common purslane."

An analysis of the wild plant occurs in *Fla. B. 11.*

Pyrethrum.—The extensive use of pyrethrum powder as an insecticide has excited some interest in the culture of the species used for that purpose, viz, *Pyrethum cinerariæfolium* and *P. roseum.* These are composite plants with flower heads somewhat resembling single chrysanthemums, which, when pulverized, form the Dalmatian, Persian, and Buhach insect powders. Pyrethrum appears to be grown on a commercial scale in this country thus far only in California. The conditions and method of successful culture and the relative merits of the two species are discussed in *Cal. R. 1882, p. 112.* The *P. cinerariæfolium* "has found great favor in California, and its culture in Merced County, as well as in Los Angeles County, has assumed large proportions." The culture of this species, so far as known, had only been carried on on level land with plentiful irrigation, but the fact that nearly all species of Pyrethrum are natives of mountains seemed to indicate that the hot plains would not be the best place. Experiments in the Santa Cruz Mountains indicated the success of this species there. While *P. roseum* is the prettier species, in culture for profit it seemed evident that it could not compete with *P. cinerariæfolium.* Its yield, as tested at the station, was not one-third that of the latter, notwithstanding its larger heads. It produced few good heads the second year, and its flowering was much more gradual, so that all the heads were not ready for gathering at one time.

At the New York State Station (*R. 1888, p. 151*) seed of *P. roseum* was planted, and though the plants failed to bloom the first season, they endured the winter unharmed and gave a profuse crop of blossoms the second. Trials of the powder made from these indicated as much or more strength than that of buhach from California, which had probably lost part of its original strength.

Queensland nut tree (*Macadamia ternifolia*).—This tree has been planted for trial in California (*R. 1880, p. 66, R. 1882, p. 102*). It appears perfectly hardy, but proves

to be of slow growth during its first years. It is related to the Australian fern tree or silk oak, *Gerrillea robusta,* but its leaf more resembles holly. It is prized for its finely flavored nut.

Quince (*Pyrus cydonia* [*Cydonia vulgaria*]).—Variety tests are recorded in *Cal. Univ. B. 8, Cal. R. 1888–'89, pp. 87, 186, 195; Ga. B. 11; Ill. B. 21; La. B. 22, B. 3, 2d ser., B. 8, 2d ser.; Mich. B. 55, B. 67, B. 80; N. Mex. B. 2, B. 4; N. Y. State R. 1884, p. 22, R. 1888, pp. 94, 100, R. 1889, pp. 353, 357; N. C. B. 72; Ohio R. 1883, p. 147; Pa. R. 1888, p. 161; R. I. B. 7; Tenn. R. 1888, p. 12; Texas B. 8; Vt. R. 1889, p. 122; Va. B. 2.*

Quinoa (*Chenopodium quinoa*).—Information regarding this plant is given with some fullness in *Cal. R. 1884, pp. 102, 105,* and the results of trials in *Cal. R. 1885–'86, p. 128.* The quinoa, a plant of the same family as lamb's-quarters, is much grown in the highlands of Chili and Peru, and is adapted to the same climate as the potato. The seed, which is produced in great abundance, is highly nutritious, and in those regions much employed as human food, being made into cakes or porridge or used in soup. The plant has been introduced into France and Germany, where the seed is chiefly fed to fowls and the leaves used in the same way as spinach.

In trials at the California Station the plant was attacked so destructively by a fly that it was only by planting early enough to escape the fly that any considerable yield was obtained.

Radish.—Tests of varieties are reported as follows: *Ark. R. 1889, p. 101; Colo. R. 1889, p. 99; Ky. B. 32, B. 38; La. B. 3, 2d ser.; Mich. B. 40, B. 57, B. 70, B. 79, R. 1888, p. 107; Nebr. B. 12, B. 15; Nev. R. 1890, p. 28; N. Y. State R. 1883, p. 181, R. 1884, p. 194, R. 1885, p. 116, R. 1886, p. 235, R. 1887, p. 146; Ohio R. 1885, p. 132, R. 1887, p. 227; Ore. B. 4, B. 15; Pa. B. 10, B. 14, R. 1888, p. 149; Tenn. B. vol. V, 1; Utah B. 3, B. 12.* In *N. Y. State R. 1887, p. 146,* are given full descriptions of 43 varieties, classified according to the form and secondarily the color of the root. English and foreign synonyms are given, with an index to all the names. In the *Mich. B. 40* and *R. 1888, p. 107,* descriptions are given of 24 varieties, classified according to the color and secondarily the form of the root.

Varieties of winter radishes were planted at the New York State Station in 1882 (*R., p. 123*); also in 1885 (*R., p. 118*). "All of the varieties [tested in 1882] were less tender and more acrid than the common radish, and we think possess few qualities that would entitle them to a place in American gardens." The rat-tail Japan serpent radish (*Raphanus caudatus*) was planted at the same station in the tests of 1884 and 1885. As noted in the report of 1884, the seed pods and not the roots of this plant have been developed by cultivation. These are about double the size of the pods of the common radish, and are used as a salad or pickled in vinegar.

At the New York Cornell Station radishes were used in electrocultural experiments, and analyses were made of samples grown in full electric light, in shadow, and in the ordinary dark house. The total nitrogen was the same in all, but in the electric-light plants more of the amide nitrogen had been changed into other forms than in the others. The electric-light samples were also richer in albuminoids. At the New York State Station (*R. 1884, p. 210*) a sample of turnip-shaped and one of long radishes were examined with reference to their root system, which was found to be alike in both and rather shallow. The taproot was found to branch horizontally some distance below the body of the root, at first sparingly, then into many fibers extending 21 inches on either side of the row.

Experiments relating to the selection of radish seed are noted in *N. Y. State R. 1884, p. 196.*

Reports of germination tests of radish seeds are given in *Ala. College B. 2; Ark. R. 1889, p. 93; Me. R. 1889, p. 150; N. Y. State R. 1883, pp. 61, 70; Ohio R. 1884, p. 197, R. 1885, pp. 162, 175; Ore. B. 2; Pa. R. 1889, p. 164; S. C. R. 1888, p. 83; Vt. R. 1889, p. 108.*

Radish, white rust (*Cystopus candidus*).—A fungous disease which attacks not only the radish but nearly every member of the mustard family. Upon the leaves

it will be seen in white patches of varying size. Its most destructive effects are on the flowers and seed pods, which it often distorts into monstrosities. It passes the winter in the seed stalks, which should, therefore, be burned. All diseased parts should be removed from the plants grown for seed.. It could probably be prevented by the use of Bordeaux mixture, if such treatment was worth while. (*N. J. R. 1890, p. 350.*)

Ramie (*Bœhmeria nivea*).—A perennial shrub with herbaceous shoots, growing 4 to 8 feet high. The bark which surrounds the stalk supplies a strong and durable fiber, which may be woven into carpets, cloth, curtains, etc. It thrives in the Gulf States and on the Pacific Coast. It is propagated by division of the roots, by cuttings, layers, or seed. The first method is preferred. Two to four crops may be cut each year.

At the California Station (*B. 90*) the estimated yield of dry stalks of white-leaved ramie has been about 9,000 pounds per acre, of which at least 15 per cent may be estimated as raw fiber. Ramie will grow on alkali soils which do not contain carbonate of soda.

Ramie is a plant which rapidly exhausts the soil. Ten tons of dry stalks, the amount sometimes produced on an acre, contain 251.98 pounds of potash, 155.70 pounds of phosphoric acid, and 369.70 pounds of nitrogen. The bark alone (2.75 tons) from 10 tons of dry stalks contains 27.86 pounds of potash, 10.86 pounds of phosphoric acid, and 206.10 pounds of nitrogen (*Cal. B. 94; Nev. R. 1891, p. 20*).

A number of machines for decorticating ramie have been patented, but so far none have come into general use. In China and Japan ramie is decorticated by hand. (*Div. of Statistics, U. S. D. A., Misc. R. 1, n. ser., p. 75.*)

Rape (*Brassica napus*).—A plant which in habit of growth bears some resemblance to the Swedish turnip, but attains a height of 1 to 3 feet. It is grown for the tops, which are grazed by animals or fed as a soiling crop. Rape may be used for pasturing hogs and steers, and especially sheep. The milk of cows fed on rape is apt to be slightly flavored. Stock must be gradually accustomed to eating rape or bloating may result.

Rape is prized as an excellent crop for cleaning land of weeds. For this purpose it should be sown in drills 2 feet apart, using from 1 to 2 pounds of seed per acre. Several cultivations and one or two hoeing are necessary on foul land. Rape requires a good soil and responds to liberal manuring. The soil which affords a good crop of corn, potatoes, or turnips is generally suited to rape. It prefers a cool climate. The best variety for common use is the Dwarf Essex. (*Minn. B. 20.*)

Raspberry (*Rubus* sp.).—Tests of varieties are recorded as follows: *Ala. College B. 2, (1888) B. 1, n. ser., B. 20, n. ser., B. 29 n. ser.; Ala. Canebrake B. 12; Ark. B. 17; Cal. R. 1888–'89, p. 110; Colo. R. 1888, p. 85, R. 1890, p. 34; Del. R. 1889, p. 103; Ga. B. 11; Ill. B. 21; Ind. B. 5, B. 10, B. 31, B. 33, B. 38; Iowa B. 16; La. B. 26 (R. 1889, p. 432); Me. R. 1889, p. 256; Mass. Hatch B. 4, B. 7, B. 10, B. 15; Mich. B. 55, B. 59, B. 67, B. 80; Minn. B. 18, R. 1888, pp. 233, 284; Mo. College B. 20, Mo. B. 10, B. 13, N. Y. State B. 36, n. ser., R. 1883, p. 225, R. 1884, p. 322, R. 1885, p. 228, R. 1886, p. 255, R. 1887, p. 335, R. 1888, p. 231, R. 1889, p. 308, R. 1890, p. 276; N. C. B. 72, B. 74; N. Dak. B. 2; Ohio B. vol. II, 4, B. vol. III, 7, B. vol. IV, 6, R. 1884, p. 107, R. 1885, p. 108, R. 1886, p. 188, R. 1887, p. 253, R. 1888, p. 111; Pa. B. 8, B. 18; R. I. B. 7; S. Dak. B. 7; Tenn. R. 1888, p. 12; Tex. B. 8; Vt. R. 1888, p. 119, R. 1889, p. 123, R. 1890, p. 184; Va. B. 2; Wis. R. 1891, p. 151.*

Raspberries are classified in the Michigan bulletins above referred to, especially *B. 80*, according to the species from which they are supposed to have originated. These are the European *R. idæus* and the American *R. strigosus*, giving red or orange fruits and propagating by suckers; the American *R. occidentalis*, the source of the black caps, propagating by the tips of the stems; and varieties of *R. neglectus*, by many regarded as probable hybrids.

In *Ohio R. 1887, p. 262*, occur analyses of four varieties, and in *Ohio R. 1888, p. 113*, similar analyses of six varieties. (See *Appendix, Table III.*) In connection with the

analyses the relative value of the varieties for drying is considered with reference both to the producer's and the consumer's interest. The Ohio variety has a large amount of dry matter, but this consists largely of seed, and it is, therefore, unprofitable to the consumer; the Turner, Hansell, and Tyler are better for the consumer. Ada Gregg and Hilborn are higher in actual value, while the Shaffer is superior to any of these and yields but little less profit to the producer.

Notes on the method of cultivating raspberries may be found in *Ala. College B. 4, n. ser.; Ga. B. 15.* A fertilizing experiment upon raspberries is reported in *Mass. Hatch R. 1888, p. 43.*

At the New York State Station (*R. 1885, p. 229*) the experiment was made of planting the seeds of few-seeded and many-seeded fruits to compare the products. The fruit of the seedlings from the many-seeded fruits averaged larger but was of inferior quality.

In *N. Y. Cornell B. 25* it is noted that in numerous crossings of raspberries, blackberries, and dewberries no effects were manifest the first year.

Raspberry cane borer.—See *Blackberry cane borer.*

Raspberry gouty gall beetle (*Agrilus ruficollis*) [also called Red-necked cane borer].—An insect which infests the canes of raspberry, blackberry, and dewberry, causing irregular swellings either in the main canes or the larger branches. The adult beetle is about a third of an inch long, with a bluish-black back and copper-colored neck. The eggs are laid on the stem or at the base of a leaf. Upon hatching, the young larva begins to spirally girdle the stem. At a later period the larva seeks the pith of the stem and continues its excavations there. In the spring the transformed grub appears as a new beetle to begin the depositing of eggs for the season. Cutting out and burning all canes having the rough swellings above mentioned is the only remedy, and this must be done early in the spring. (*N. J. B. N; W. Va. B. 15, R. 1890, p. 160.*)

Raspberry rust (*Cæoma nitens*).—A disease caused by one of our most common and striking fungi, which affects raspberry and blackberry plants. It is first noticed as stunting the young parts of the plant and causing them to become yellow. Soon the leaves on one or both sides are completly covered by masses of the bright orange-colored spores. The fungus, once established, lives from year to year in the canes, and only their destruction by burning will avail anything. Its spread from plant to plant is by means of the orange-colored spores. The effect produced by the fungus on its host is often peculiar. In place of a single strong fruiting branch a cluster of sometimes a dozen weak yellow ones appear. The diseased canes die the third year after they are attacked. Spraying with Bordeaux mixture is an effective remedy for the disease. (*Mass. State R. 1890, p. 224; Md. R. 1890, p. 115; Vt. R. 1890, p. 143.*)

Red-necked cane borer.—See *Raspberry gouty gall beetle.*

Red spider (*Tetranychus telarius*).—This insect is often very troublesome in the greenhouse and window garden as well as out of doors. It flourishes best in a dry atmosphere, and may be destroyed by spraying plants with water or keeping them in a moist atmosphere. The spraying must be done to the underside of the leaves. Where practicable, the fumes of sulphur will be found very satisfactory. Care must be taken that the sulphur be not ignited or the plants will be killed, the fumes of *burning* sulphur being poisonous to plants. Kerosene emulsion may be used with advantage if sufficient force is given the spray and the insecticide is applied to the underside of the leaves. (*Iowa B. 5; Mass. Hatch B. 4, B. 19; N. J. B. 75; N. C. B. 78; Ore. B. 18.*)

Redtop.—See *Grasses,* under *Bent grasses.*

Rescue grass.—See *Grasses.*

Rhode Island bent grass.—See *Grasses*

Rhode Island Station, Kingston.—Organized under act of Congress March 23, 1888, as a department of the Rhode Island College of Agriculture and Mechanic Arts. The staff consists of the president of the college, director and agriculturist, horticulturist, chemist, apiarist and poultry manager, veterinarian, assistant agriculturist, assistant chemist, farmer, and clerk. The principal lines of work are chemistry; analysis and control of fertilizers; field experiments with field crops, vegetables, and fruits; agriculture; veterinary science and practice; and apiculture. Up to January 1, 1893, the station had published 4 annual reports and 20 bulletins. Revenue in 1892, $16,678.

Rhubarb (*Rheum* spp.).—Of the common vegetable rhubarb(*R. rhaponticum*) six varieties were tested at the Michigan South Haven Substation (*Mich. B. 67, B. 80*). A list of thirteen varieties planted at the New York State Station is given in *R. 1884, p. 23.* An analysis as to fertilizing ingredients is given in *Mass. State B. 16.*

The cultivation of Russian rhubarb for its root as a drug is noted in *Mass. State R. 1889, p. 177.* The plant had been successfully grown for several years and well-matured seed collected each year. Three species purporting to be medicinal rhubarb were on trial in California (*Sup. Bien. R. 1887, p. 126*) and were proving successful on sandy loam.

A germination test of rhubarb seed is reported in *Ore. B. 2.*

Ribgrass.—See *Weeds.*

Rice (*Oryza sativa*).—Rice belongs to the grass family and in growth resembles some swamp grasses. Common rice has been cultivated in Asia from remote ages. Other species or varieties of rice are described by botanists, but only our common rice is of economic importance. Rice was introduced into Carolina in 1698. It now constitutes one of the most important crops of the lowlands of South Carolina and Louisiana, and is grown in other Southern States.

MILLING—USES OF BY-PRODUCTS.—The rice planter ships his rough rice to the mills in barrels containing 162 pounds of rice. From this quantity of rough rice the mills secure 95 pounds of clean rice, 8 pounds of polish, 30 pounds of bran (variable), and 29 pounds of chaff and waste products (*La. B. 24*). The straw on the farm after threshing has some nutritive value. Rice polish is a fine, flour-like substance, very rich in starchy material. Rice bran is coarser and less nutritious than polish, but is a valuable feeding stuff. The rice mills of South Carolina mix rice polish and rice bran, selling the mixture under various names, as rice feed, rice meal, etc. This is nutritious and in the vicinity of the mills is a cheap feeding stuff (see *Pigs, feeding.*)

COMPOSITION.—For composition of rice and its various by-products see *Appendix, Tables I and II.*

CULTURE.—Nearly all the rice of commerce is grown on irrigated land, where the yield is greater and the cultivation less difficult than on upland. Drained land is thoroughly prepared with the plow. Then the rice, from 1 to 3 bushels per acre, is sown broadcast and harrowed in. The time of planting varies from March till June. After the seed is planted the field is covered with a few inches of water. The frequency of irrigating varies. Some planters drain off the water after the seed has germinated, flooding again when the plants are about 4 inches high. From this time some keep the water on the land continuously until a short time before harvest. Others flood the field for a few days, draw off the water, and after an interval repeat the flooding. All are careful to prevent the covering of the tops of the plants by the water.

The great difficulty in rice culture is to prevent worthless grasses from interfering with the growth of rice. Some mow and burn off the fields in the fall. Others irrigate early in the season and then plow under the young grass, after which rice is sown. Hand weeding is too expensive for the large planter, hence mowing is sometimes resorted to, after which the rice makes a more rapid growth than the troublesome grasses (*Rep. of Commissioner of Agr. of La. for 1888, App., p. 72*).

Small crops of rice for domestic consumption are grown in the highlands of the Southern States. There the seed is planted in drills at such distance as to allow of cultivation with the plow. The plants are thinned to a few in the hill, the hills being about 10 inches apart (*Fla. B. 12*). The crop is afterwards cultivated with hoe and plow. For irrigated land in Louisiana the station suggests a mixture of two parts cotton-seed meal and one part acid phosphate applied on the plowed land (*La. B. 15, B. 24*).

Irrigated rice is cut either by hand or by machinery. Rice is harvested late in August or early in September. The yield of clean rice varies greatly, being usually between 600 and 1,500 pounds (*Rep. of Commissioner of Agr. of La. for 1888, App., p. 76; La. B. 15*).

DISEASES.—"The only disease which has been noted by writers on rice is a blight or failure of the head to fill with grain; this is called *brusone*, and is usually prevented by changing seed. The real cause is unknown. In Louisiana it occurs on first year new ground." (*La. B. 15.*)

"The annoying blight in rice, popularly known as *Riz foux*, is caused by excessive irrigation," according to J. T. Gilmore in *Rep. of Commissioner of Agr. of La. for 1888, App., p. 72.*

(See also *Fla. B. 12, B. 16; La. B. 27; N. C. B. 23, May, 1882.*)

Ringworm.—A skin disease of cattle and horses due to a fungus. It is most frequently found on cattle under two years old, but calves do not seem to be susceptible. It occurs in winter on cattle fed in the barn and on those which are left on the range. Patches of skin become partially denuded of hair, and present a raised and scabby appearance. The surface of the affected spot is dry, and when rubbed a fine scurf comes off. These patches vary in size and occur generally on the skin around the orbits of the eyes, on the face, neck, or along the spine.

On the more tender skin of the horse the disease causes greater irritation than in the case of cattle. It spreads more rapidly on the horse and spontaneous recovery is less frequent. Cattle may convey the disease to horses or even to human beings. Infected brushes, currycombs, and harness may transmit the disease. Diseased animals should be kept by themselves. The hair for some distance around affected patches should be clipped and the diseased parts washed with hot water containing some fungicide and soft soap. Then apply some antiparasitic remedy, as tincture of iodine, iodine ointment, citrine ointment, or solutions of corrosive sublimate, carbolic acid, and sodium sulphite. Iodine is excellent when the disease is near the eye. One application of the following blistering ointment is useful: Red iodide of mercury one part, lard six parts, and a few drops of croton oil. (*Ark. B. 16.*)

Roads.—Information regarding road-making has been published in *Ala. College B. 19* and *Tenn. B. vol. III, 3*, from which the following brief statements have been obtained:

When possible, the grade of a road should not be steeper than 1 in 35, and a slight grade, 1 in 125, is recommended as favorable to drainage. Away from cities and where funds are limited the roadbed may be as narrow as 16 feet, but somewhat wider on a curve. A cross section of a roadway should not be a continuous curve, but should consist of two inclined planes united in the center of the road by a single curve. These planes should slope one-half inch in 24 feet for a road with a broken-stone surface, the slope increasing with the roughness of the surface. On a steep hillside there should be but a single slope and that should incline towards the hill.

In the Macadam road the bed is thoroughly drained and covered with a layer of several inches of broken stones. After rolling, or packing by travel, other layers of broken stone are added and packed until the stone work is 6 to 12 inches thick. The Telford road is made in much the same way, the first layer, however, consisting of blocks of stone of an irregular pyramidal shape, larger below than above, and set close together by hand. Stones larger than 4 or 5 inches in any one direction have

no place in road construction, and except in the lower layer 2½ inches in any direction is the greatest limit.

A steeper grade than that given in the second column of the following table should never be allowed on a country road. The figures in the table are true of an earth road in "fair" to "first-class" condition.

	Force required to draw a gross load of 2,240 pounds.	Steepest grade (rise per 100 feet), on which vehicle will not roll back.	Draft on a level compared with that on different grades.—Rise in feet per 100 feet.					
			0	3	6	9	12	15
	Pounds.	*Feet.*						
Earth road	200	8.9	1	1.3	1.7	2.0	2.3	2.7
Gravel road	143½	6.4	1	1.5	1.9	2.4	2.9	3.3
Macadam road	65	2.9	1	2.0	3.1	4.1	5.1	6.1
Telford road	46	2.0	1	2.5	3.9	5.4	6.8	8.2
Plank road	41	1.8	1	2.6	4.3	5.9	7.5	9.1

Rocky Mountain bee plant.—See *Bee plants.*

Root crops.—In some localities root crops form an important part of the diet of cattle and sheep. The roots most used as stock feed are turnips, ruta-bagas, beets, mangel-wurzels, and carrots. Root crops require a rich, deep soil and thorough tillage, but produce large yields of succulent food. For example, the Massachusetts State Station (*R. 1888, p. 139*) grew Vilmorin sugar beets at the rate of 22.95 tons per acre and carrots at the rate of 19.52 tons per acre.

The Utah Station (*R. 1891, p. 36*) states that root crops, with the exception of the sugar beet, are less successful in the dry climate of that State than in the East.

The New York Cornell Station (*B. 37*) recommends early planting for root crops. Roots on the Cornell University farm in 1889 cost 7 cents per bushel for seed and labor. See also *Minn. R. 1888, p. 102.* For analyses of root crops see *Appendix, Tables I and II.*

Root tubercles.—See *Leguminous plants.*

Rose chafer (*Macrodactylus subspinosus*) [also called Rose bug].—The adult insect is a beetle about three-fourths of an inch long, of a dirty yellow or light brown color. It feeds upon the leaves, flowers, and fruit of nearly every plant except evergreens. It prefers the rose, but when that is not in sufficient abundance it attacks other plants, especially grapes. It has been exceptionally troublesome in New Jersey, where the station has thoroughly investigated its life history, discovering several new facts. When this insect is very numerous poisons are too slow in their action to accomplish much relief. Kerosene emulsion, whale oil soap, hot water (125°–130° F.), pyrethrum, and dilute whitewash are all recommended as of more or less value as insecticides for the rose chafer. Perhaps the best means is to knock them into sheets or collectors of any convenient shape and size and kill them by scalding or with kerosene. They should be collected twice a day for two weeks, after which but little damage will be done to vineyards. They usually appear at the time Concords are in bloom. To keep them away from vineyards plant Clinton vines, spiræas, rosebushes, and magnolias to attract them.

The eggs may be destroyed by carefully cultivating all loose soil, in which they are always deposited. Plowing will destroy them. No natural enemies are as yet known to destroy either the eggs or the larvæ, which greatly resemble those of the "white grub" or May beetle. (*N. J. B. 75, B. 82, B. 86, R. 1891, p. 350.*)

Rotation of crops.—A number of stations have begun experiments on the rotation of crops, but only reports of progress have been issued thus far. At the Indiana Station (*B 27, B, 32, B, 41*) wheat grown continuously during six years on the

same land has been compared with wheat grown in rotation with corn, grass, beans or roots, and oats. The yields have been increasingly favorable to rotation. At the Missouri Station (*College B. 18*) relatively large yields were obtained by growing corn in rotation with other crops. The Louisiana Stations recommend the following rotation for the South: Corn, oats followed by peas the same season, cotton (*La. B. 8, 2d ser.*). At the Maryland Station (*R. 1889, p. 130, R. 1890, p. 99, R. 1891, p. 366*) during three years the lasting effects of stable manure have been observed in connection with the rotation of crops. The New Jersey Station advises not to grow tomatoes after corn since the same insect pests are destructive to both crops. See also *Ark. B. 18, R. 1890, p. 5; Del. B. 16; Ill. B. 13, Kans. B. 20; N. C. B. 73.*

Ruta-baga (*Brassica campestris* var.).—Tests of a moderate number of varieties may be found in *Colo. R. 1889 p. 103; Mass. State R. 1888, p. 142, R. 1889, p. 169* (photograph); *Mich. B. 46, B. 60; Minn. R. 1888, p. 262; N. Y. State B. 14, R. 1882, p. 123, R. 1883, p. 182, R. 1884, p. 199, R. 1885, p. 118; Ore. B. 4; Pa. R. 1890, p. 157.*

Analyses of ruta-bagas occur in *Kans. R. 1889, p. 116* (showing food ingredients and nitrogen, albuminoids and other); *Mass. R. 1888 p. 145, R. 1889 p. 187, R. 1890, pp. 293, 299, R. 1891, pp. 318, 324.* See *Appendix, Tables I and II.*

Germination tests of ruta-baga seed are reported in *Ohio R. 1884, p. 199; Pa. B. 8; Vt. R. 1889 p. 111.*

Rye.—The experiments with this crop by the stations have been chiefly with reference to its value as a forage plant. At several of the stations in the Southern States it has been found that rye sown in the summer will give an abundant amount of green fodder at three or four cuttings during the fall and winter (*Ala. College B. 16, n. ser.; Ala. Canebrake B. 9*). At the Vermont Station rye sown in September gave abundant green fodder for cows by the middle of May, but after May the stalks became tough and unpalatable (*Vt. R. 1889, p. 87*). Seaweed proved an efficient fertilizer for rye in an experiment at the Rhode Island Station (*R. I. R. 1890, p. 13*). At the Arkansas Station pea vines plowed under largely increased the yield of rye forage (*Ark. B. 18*). See also *Cal. R. 1890, p. 209, Colo. R. 1889, p. 105, R. 1890, p. 284; Nebr. B. 15, B. 19; Pa. B. 5 (1888), B. 15 (1886); S. Dak. B. 21.*

Sainfoin (*Onobrychis sativa*) [also called Asperset or Esparcet].—A perennial leguminous plant having somewhat the appearance of alfalfa. It grows about a foot and a half high with a weak stem, rather long, pinnate leaves, and flowers of a pink color in a loose spike 2 to 4 inches long on a long, naked stalk. The flowers are succeeded by short single-seeded pods marked with raised lines. It is widely used in Europe for pasturage and hay, especially for sheep. It prefers light, dry, calcareous soils. It has been tried in this country but without great success except in a few localities. At the California Station, where it has been grown a number of years, it has not done well, and the evidence regarding its value elsewhere in the State is conflicting (*Cal. R. 1890, p. 213.*)

At the Massachusetts State Station it has yielded a light crop and has been considerably winterkilled (*Mass. State B. 34, R. 1889, p. 159; R. 1890, p. 161, R. 1891, p. 189*). For analyses at different stages of growth see *O. E. S. B. 11; Pa. R. 1887, p. 139.* An analysis of sainfoin hay with reference to fertilizing constituents gave nitrogen 2.63, potash 2.02, phosphoric acid 0.76 per cent (*Mass. State R. 1890, p. 323*).

(*Colo. R. 1888, p. 32, R. 1889, p 95, R. 1890, p. 188; Iowa. B. 11; Me. R. 1889, p. 162; Mo. College B. 35, Nebr. B. 6, B. 17; Ore. B. 4; Pa. R. 1887, p. 138; Wyo. B. 1.*)

Salsify (*Tragopogon porrifolius*) [also called Oyster plant].—Six varieties were tried at Minnesota Station (*R. 1888, p. 255*) and two at the Nebraska Station (*B. 12*). Germination tests of the seed are reported in *Me. R. 1889, p. 150; N. Y. State R. 1883, p. 70; Ohio R. 1885, p. 167; Ore. B. 2; Vt. R. 1889, p. 108.*

For black salsify see *Scorzonera.*

The Spanish salsify (*Scolymus hispanicus*) is figured and fully described in *N. Y. Cornell B. 37.* The root is larger and lighter colored than that of ordinary salsify; its flavor is less pronounced, but when it is carefully cooked it has an agreeable

quality somewhat intermediate between that of salsify and parsnip. Its prickly leaves are a drawback, but it is considered well worth introducing into American gardens.

Salt.—Common salt is composed of the metal sodium and the gas chlorine. Its use as a condiment and preservative is universal. Its use as a fertilizer has been in some cases attended with beneficial results, but since it supplies no essential element of plant food it is probable that the little value it may possess for this purpose depends upon its physical action (attraction for water, etc.), or on its ability to set free more important constituents.

At Kansas Station (*B. 7, R. 1889, p. 39*) salt applied to wheat and oats at the rate of 300 pounds per acre increased the yield slightly, but at an actual financial loss; applied to oats at the rate of 150 pounds per acre the yield was less than where no fertilizer was applied.

In experiments at Minnesota Station (*R. 1888, p. 159*) 50 bushels of salt per acre increased the yield of oats 5 bushels per acre, of oat straw 200 pounds; of flaxseed 1½ bushels and flax straw 500 pounds, and of beets 1½ tons per acre. No increase of potatoes was produced by salt.

Scale insects.—There are several genera and many species of these minute pests known to cause greater or less injury to some of our most important plants. They are about one-tenth of an inch in diameter, of various colors, usually grayish white. The male ultimately develops two wings, but the female is wingless. After laying her eggs the female shrivels up. The young hatch, run about for a little time, and then attach themselves to trees by piercing the bark to suck the juice. They are stationary afterwards, and secrete their well-known scales. These are so plentiful as to often cover a leaf or twig, and do great damage. Their natural enemies are numerous, and for the most part keep them in check. If they spread, whale-oil soap solution may be used. The trees should be given some winter wash, as a strong lye. This will remove and kill many of the adult scales. Sprays of kerosene emulsion are best used when the young have just hatched and are still running about. (*Fla. B. 9; Me. R. 1888, p. 184; N. J. B. K; N. Mex. B. 7; Ore. B. 5, B. 18.*)

Schrader's brome grass.— See *Grasses*, under *Rescue grass*.

Scorzonera (*Scorzonera hispanica*) [also called Black salsify].—This is briefly noted in *Minn. R. 1888, p. 255*, having been planted at that station. The root had the flavor of salsify, but was black and inferior in size. The seed has been included in germination tests, as reported in *N. Y. State R. 1883, pp. 70, 267; Vt. R. 1889, p. 108.*

Screw worm (*Compsomyia* [*Lucilia*] *macellaria*).—The larva of a fly found all over the country, but most liable to be met with in Texas and adjoining States. The fly is slightly larger than the common house fly, of a bright metallic green, with three black stripes upon its back. Its eyes are dull red and very prominent. It lays its eggs in great abundance in wounds or natural openings of animals or man. These hatch a small white grub in from two to ten hours (some claim in as many minutes). The young larvæ at once bore their way into the flesh, making a deep, running wound. The odor is very characteristic and serves to attract more flies. These lay their eggs and a new lot is hatched. If left alone, the animal will die from blood-poisoning in a short time. The mature grub is about three-fourths of an inch long and one-eighth of an inch in diameter. It tapers toward the head and there has two sharp, black hooks by which to hold on. The body is divided into segments, and these are clothed with a circle of stiff bristles, giving it the appearance of a screw.

The treatment is to get the worms from the wound and let it heal. By injecting into the wound chloroform, solution of corrosive sublimate (60 grains in 1 pint of water), calomel, crude carbolic acid, kerosene, turpentine, cresylic ointment, or fresh pyrethrum, the worms will be killed or driven from the wound. If the wound is carefully washed out and the flies are kept away it will soon heal,

Corrosive sublimate and calomel will sometimes affect the stock with mercurial poisoning, especially if put where they can lick the wounds. The carbolic acid and corrosive sublimate are good antiseptics and will aid the wound in healing. Preventive measures are to put tar, grease, or fish oil on all wounds every day until healed. Keep stock free from ticks, as half the cases of the attacks of screw worms are said to start at a place where a tick is killed, giving the necessary blood in which to lay the eggs. All dead animals should be burned or buried at least 2 feet deep to prevent the flies from laying their eggs in the carcasses or those already laid from escaping. (*La. B. 2, 2d ser.; Miss. B. 14; Tex. B. 12, R. 1888, p. 45.*)

Seaweeds.—For composition of different kinds of seaweed see *Appendix, Table IV.*

Seeds.—The selection of seed deserves greater attention than is generally given it. Seeds are often sown without any apparent regard to their purity or vitality. This careless method causes serious losses in time and money before a good stand of a given crop is secured. In many foreign countries laws regulate the sale of seeds, and the dealer guarantees the purity, authenticity, and vitality of all seeds. In this country everything is left to the honesty of the dealer and the good judgment of the purchaser. The tests made at the stations show that as a rule seeds secured directly from the producer may be relied on, but that old and inferior stock is often kept by retail dealers. This is especially true of kinds of seed for which the demand is small and irregular. Imported seed is often of very poor quality.

Seeds may either have a low germinating power or may be mixed with foreign substances. These impurities may consist of chaff or dirt, which simply increases the bulk or weight of the packages, or they may be the seeds of other plants, oftentimes of troublesome weeds.

Imported clover, grass, and other forage seeds are very liable to adulteration. From tables prepared at several stations it is found that they average 9.8 per cent of adulteration, while in one case 33⅓ per cent by weight of a sample of clover seed was made up of finely crushed quartz, colored to resemble the seed.

To protect himself from being imposed upon, every farmer should examine all seeds before planting. With the aid of a small magnifying glass almost any kind of adulteration can be detected.

Seeds should also be tested for vitality. This may be done in various ways. Where seeds are to be tested on a large scale a good device is what is known as the Geneva tester. This consists of a copper box, 10 by 14 inches square and 3 inches deep, provided with a sliding lid of glass or copper. About an inch below the top, on the long sides, are placed narrow ledges, one on each side, upon which are to rest stout wires holding pockets in which to put the seeds. The pockets are made of cotton flannel or similar cloth. A strip the width of the box is required, and this is plaited into folds about an inch deep. These are sewed in such a manner that wires may be run through them, leaving the pocket suspended between adjacent wires. The strip of cloth should be long enough for about fifty pockets, the capacity of the box. When the wires are pressed together and placed upon the ledges, the cloth should hang in close folds. At the ends of the system of pockets the cloth should hang down to touch the bottom of the box. Water to a depth of about a half inch is poured into the box. The cloth becomes saturated by capillary attraction, while the tight cover prevents evaporation. Each plait or pocket is numbered, and when slid open receives the counted seeds, after which the wires are slid together, inclosing the seed in a damp pocket. Examination is made from day to day, and the sprouted seed removed and counted. In this way the percentage of good seed may be learned. This apparatus has been tested by several stations, and is considered one of the best of its kind.

Another and simpler method is to place the counted seeds between folds of cloth kept damp, but not too wet, between deep pans or dishes. Another method is to use a sieve, the bottom of which is covered with a piece of muslin. On this are placed the seeds, over which is spread another piece of muslin. Over this is spread

a layer of sand a half inch deep, and the whole kept moist. In another method the seeds are germinated in soil in shallow pans.

By either of the above methods the per cent of seeds liable to grow may be ascertained. All these will give higher results (about 8 per cent on the average) than can be expected in actual field trial, but this will not affect the determination of the relative value of the seeds.

Where large numbers of seeds are to be tested, and several tests made at one time, the Geneva tester will probably be found the most satisfactory. A single test of a lot of seeds is not sufficient, but several should be made, and the average of these taken for the index of vitality. Any deficiency in the per cent of germinating seed may be corrected by increasing the amount of seed used. In this way no loss of time in replanting nor disappointment in securing a sufficient stand need be experienced.

The following table gives the average per cent of the seeds of different kinds which germinated in tests at about a dozen stations in this country:

Kinds of seed.	Per cent.	Kinds of seed.	Per cent.	Kinds of seed.	Per cent.	Kinds of seed.	Per cent.
Artichoke	69	Cotton	70	Mustard	70.5	Sorghum	46
Asparagus	61	Cucumbers	68	Oats	91	Spinach	49.6
Beans	86	Eggplant	41	Okra	79	Squash	62.6
Beets	60.1	Endive	34	Onions	66	Sugar beet	44
Brussels sprouts	75	Grasses	47.5	Parsley	53.4	Tobacco	51
Cabbage	70.5	Jute	47	Parsnip	44.2	Tomato	73
Carrot	48.5	Kale	67	Peas	86	Turnip	72
Cauliflower	73	Kohl-rabi	75	Pepper	60	Watermelon	60.3
Celery	73.3	Leek	39	Pumpkin	55.6	Wheat	97
Clover and legumes for forage	73.3	Lettuce	72	Radish	73.7		
		Lima beans	74	Ruta-baga	82		
Corn	86	Muskmelon	83	Salsify	55		

Some of the above figures may seem rather low, but it must be considered that all kinds of seeds were used and that some deteriorate rapidly with age. A table showing the average per cent of germinations of twenty kinds of seeds, mostly garden vegetables, from maturity until ten years old, is here given:

Age of seed.	Per cent.	Age of seed.	Per cent.	Age of seed.	Per cent.
Mature seed	74	Four years old	60.3	Eight years old	33.1
One year old	+73	Five years old	45.5	Nine years old	30
Two years old	—73	Six years old	42	Ten years old	19.6
Three years old	65	Seven years old	35.1		

While this table indicates in a general way that the vitality of seed decreases with increasing age, these averages can not be applied to every kind of seed. Beet, cucumber, muskmelon, ruta-baga, tomato, and turnip seeds decrease in vitality very gradually from year to year, while others, like celery or parsnip seeds, are practically worthless after they are two years old. In the tests on which the table is based the germination of the older seeds was forced, and is no doubt higher than could be obtained in a field trial. Old seeds may, as a rule, be recognized by their duller color.

(*Ark. R. 1889, p. 92; Colo. R. 1888, p. 99; Del. R. 1889, p. 46; Ill. B. 12, B. 15; Ind. B. 32; Kans. R. 1888, p. 337, R. 1889, p. 13; Me. R. 1888, p. 136, R. 1889, p. 149, R. 1890, p. 107; Mich. B. 2, B. 57, R. 1888, p. 110, R. 1889, p. 17; Minn. B. 12; Nebr. B. 12; N. Y.*

State R. 1883, R. 1884, R. 1885, R. 1886, p. 56; N. Y. Cornell B. 32; N. C. B. 73, R. 1888, p. 134; Pa. B. 10, B. 11, R. 1889, p. 163; S. C. R. 1888, p. 92; Tenn. B. 2.)

The following general statements regarding the germination of seeds, especially under glass, were compiled for the most part from *N. Y. Cornell B. 32.*

(1) A constant temperature produces more rapid sprouting and gives a greater total number of plants than a varying one. About 74° F. will give better results than a varying temperature whose mean exceeds this by several degrees.

(2) Sprouting will be more rapid and a higher total will be secured if less than the usual amount of water used in greenhouses be employed. The use of water beyond the amount required to moisten the soil is positively injurious to the seed, often causing it to rot. However, a great gain in rapidity of sprouting may be secured by soaking the seed in water. The longer the soaking, within reasonable limits, the greater the gain. This gain is only apparent, as may be seen by deducting the length of time the seed is soaked from the time required for the unsoaked seed to germinate. This fact may be made of practical use where time is an object and conditions for planting are unfavorable.

(3) Variations in the per cent of germinations may be affected by the character of the soil, a sandy loam giving higher and quicker results than a clay soil.

(4) Where seeds in the same lot vary in color widely differing results may be expected.

(5) As a rule the heaviest seeds in a package will produce the best results. However, the lighter seeds will sometimes give earlier results if their lightness is due to their having come from immature fruit.

(6) Some seeds will sprout in the light, but not all. As a rule all seeds do best in the dark.

(7) Northern seed appears to germinate earlier and more abundantly than southern-grown seed of the same varieties.

The following are some of the results of tests of particular kinds of seed at the stations:

Cauliflower seed has been experimented with to see if the claims of superiority for foreign seed over domestic were warranted. German or English seed has been found to have no advantage over that grown along Puget Sound, Washington, while the latter is said to be much the cheaper. (*N. Y. State R. 1890, p. 288; Minn. B. 12.*)

Clover seed has been found to be very largely adulterated, especially with weed seeds. The weeds most commonly found are English plantain, sheep sorrel, chickweed, pigeon grass, oxeye daisy, dog fennel, and clover dodder. Among these are serious enemies to introduce into a meadow, the last especially being capable of doing great damage. (*Nebr. B. 12; N. C. B. 73; S. C. R. 1888, p. 91.*)

Corn tested at the Kansas Station gave 65 per cent vitality for 20 varieties of white corn, 70 per cent for 5 varieties of red or mixed, and 77 per cent for 21 varieties of yellow. The yield from these same lots was yellow 60 bushels per acre, white 76, and red and mixed 90 bushels. The practice of gathering selected seed corn and storing it in a dry, airy place is to be commended, but retaining the seed ears in the husk has no advantage. (*Kans. B. 30, R. 1889, p. 13; Ohio B. vol. IV, 1; Tenn. B. 2.*)

Oats of the same variety grown in different soils and conditions show important differences due to the kind of seed used. Oats harvested while still in the dough make the best seed for yield and early maturity. Heavy seed oats will produce the largest crop in dry seasons, but light seed is preferable in wet seasons, probably because of the greater number of seeds sown. Hot-water treatment, *i. e.*, soaking the oats for fifteen minutes in water heated to 132° F., tends to produce a larger yield. (*Kans. B. 13, B. 29; Mo. B. 15.*)

Peas infested with weevils do not make as good seed as those not so affected. The idea that the germ of the pea is never touched by the weevil is false. The same is true of weeviled beans. Out of 1,800 weeviled beans, but 30 per cent could be forced to germinate, while of a like number of sound ones 95 per cent grew. Of 500 weeviled

peas of 10 varieties, but 25 per cent grew, while 97 per cent grew of a similar lot of sound ones. (*Kans. B. 19; Canada Expt. Farms R. 1891, p. 203.*)

Tomato experiments with seed from immature fruits and from first ripe fruits have given conflicting results, and it is by no means clear that selection based on either of these conditions will give earlier or better fruit. (*Mich. B. 57; N. Y. Cornell B. 32, B. 45; N. Y. State R. 1884, R. 1885, B. 30.*)

The effect of chemicals and electricity on germination has been investigated to a considerable extent in the hope of finding some means by which germination might be hastened without reducing the vitality of the seed. Tests of different chemicals indicate that while in some cases they may hasten germination, they almost always injure the vitality of the seed.

Recent investigations with electricity tend to prove that it hastens the germination of some seeds and increases their product. In the case of seeds of peas, beans, barley, and sunflower, placed between copper disks and electrified for two minutes from an induction coil, germination was effected in half the time required by non-electrified seeds under the same conditions. (*Mich. R. 1888, p. 110; Mass. Hatch. B. 16.*)

Separators (for creaming milk.)—See *Creaming of milk.*

Serradella (*Ornithopus sativus*).—A low annual leguminous forage plant, slightly resembling vetch. It prefers a moist, sandy soil. Serradella draws a part of its nitrogen from the atmosphere.

At the Kansas Station (*R. 1889, p. 42*) it failed completely, attaining a height of only a few inches. At the Oregon Station (*B. 4*) it grew remarkably well, throwing out branches 40 inches long. In Nebr. (*B. 12*) it withstood drought, but made only a slight growth. One season at the Massachusetts State Station (*Mass. R. 1887, p. 51, R. 1888, pp. 119, 223, R. 1889, p. 190, R. 1890, p. 173*) serradella yielded 9½ tons of green fodder per acre; another season the yield was 13½ tons. Results from feeding green serradella have been very satisfactory. (*Conn. Storrs B. 5, B. 6; Me. R. 1889, p. 167; Mich. B. 47; Nev. R. 1890, p. 16; Pa. R. 1889, p. 165.*)

Service berry (*Amelanchier* spp.) [also called June berry or Shad bush].—A native small tree or shrub bearing a fruit resembling a huckleberry.

The variety *oblongifolia* of *A. canadensis* was planted at the New York State Station (*R. 1883, p. 226, R. 1886, p. 167*). Three dwarf sorts, planted at the Michigan Station, are briefly noted in *B. 67, B. 80.* The flavor of the common variety was regarded inferior to that of the best huckleberries, and the productiveness was low. The others were not yet fully tested. Two varieties of each were planted at the Rhode Island Station (*B. 7*) and the South Dakota Station (*B. 7*) and several at the Iowa Station. According to *Iowa B. 16* there are several varieties of dwarf June berries native in that State believed to have originally come from the eastern slope of the Rocky Mountains. "All of them produce bountiful crops of really excellent fruit—comparing favorably with the huckleberry—but the birds are so fond of it that where only a few bushes are grown it is difficult to secure a ripe berry unless the bushes are covered." Where an acre or more is grown the loss is not noticed. The Iowa varieties evidently belong, at least in part, to the western *A. alnifolia;* the Michigan varieties would seem to belong, partly at least, to the eastern *A. canadensis.* According to *Nebr. B. 18* both these species are native in Nebraska.

Sheep.—Cost of fattening.—At the New York Cornell Station (*B. 8*) in one experiment a lot of lambs received timothy hay, whole corn, and roots. The nutritive ratio of the ration was 1:10.9, and the cost of making 100 pounds increase in live weight was $7.59. Another lot was fed on wheat bran, cotton-seed meal, clover hay, and roots; nutritive ratio 1:4.2. The cost of 100 pounds gain in this case was $6.03. Another lot received corn, wheat bran, cotton-seed meal, timothy hay, and roots; nutritive ratio 1:6.5. The cost of 100 pounds of gain was $6.36. The fourth lot had the same ration as the preceding lot except that roots were omitted; nutritive ratio 1:6.3. The cost of 100 pounds of gain was $7.82.

At the Michigan Station (*B. 84*) lambs fed on oats, bran, and corn silage, all valued at current prices in Wisconsin, made 100 pounds gain in live weight at a cost of $4.96. When roots were used instead of silage the cost per 100 pounds of increase in live weight was $4.38.

At the Wisconsin Station (*R. 1891, p. 5*) wethers nine months old fed on a ration of shelled corn, corn silage, and corn fodder, the ration having a nutritive ratio of 1:10, cost at current prices in Wisconsin $3.70 per 100 pounds of gain in live weight. A similar lot fed on oats, oil meal, clover silage, and clover hay, the ration having a nutritive ratio of 1:3.6, made a gain at a cost of $5.53 per 100 pounds increase in live weight. In another experiment at the same station, wethers shorn in December and fed on meadow hay, sugar beets, oil meal, oats, and whole corn, made a gain at a cost of $4.70 per 100 pounds. A similar lot given the same feed, but not shorn until spring, made 100 pounds gain at a cost of $4.40.

At the same station (*Wis. R. 1890, p. 10*) a lot of lambs eating corn, corn silage, and corn fodder, cost per hundredweight of live increase $3.28. A similar lot fed on corn, oats, clover silage, and clover hay, cost $4.06. Another like lot on oil meal, oats, clover silage, and clover hay, cost $5.31.

Lambs ten days old were fed on whole milk, and required 579 pounds of milk per 100 pounds of increase in live weight, making the cost $3.47. When the lambs were a month old, the ration was changed to skim milk, oats, green clover, and green corn. The cost during four weeks was $2.30 per 100 pounds of gain in live weight. The cost gradually increased with the age of the animals, reaching $4.50 in September.

Lambs and ewes together were soiled with green clover and green corn, receiving also a grain ration of oats. The cost of increase in live weight of ewes and lambs until weaning time was from $3.22 to $6.66 per 100 pounds. When the lambs were separated from the ewes and put on dry food, they made growth at a cost of $5.10 per 100 pounds of increase.

At the Iowa Station (*B. 17*) lambs eating oats, linseed meal, bran, and hay, cost $6.20 per 100 pounds gain in live weight; a similar lot on shelled corn, hay, and oat straw, cost $5.70 per 100 pounds gain; a third lot on oats, corn, bran, linseed meal, and hay, cost $5.65 per 100 pounds of increase in live weight.

The Massachusetts State Station (*R. 1891, p. 128*), with food stuffs higher than in the West, fattened wether lambs at the following cost per 100 pounds of live increase: $9.35, $11.66, $10.07, $10.99, $13.40, and $10.70. The net cost, after subtracting 80 per cent of the manurial value of the food, was respectively $5.83, $7.29, $6.32, $5.76, $7.06, and $5.62.

At the Texas Station (*B. 10*) sheep fed on cotton seed valued at $7 per ton and corn silage at $2 per ton cost $2.82 per 100 pounds live increase; those on cotton-seed meal at $20 and cotton-seed hulls at $3 made their gain at a cost of $4 per 100 pounds.

For cost of wintering ewes see below.

Feeding grain to unweaned lambs.—In two experiments at the Wisconsin Station (*B. 32, R. 1891, p. 27*) the lambs of ewes that received grain while on pasture fattened no faster than those having only pasturage. It paid to feed directly to the unweaned lambs all the grain they would eat. Grain-fed lambs fattened more rapidly and were valued at three-fourths of a cent per pound higher than the other lots.

Carbonaceous vs. nitrogenous rations.—In three experiments at the New York Cornell Station (*B. 2, B. 8, B. 47*) lambs fed on nitrogenous foods drank from two to three times as much water as those on a carbonaceous diet.

In two experiments at the Wisconsin Station (*R. 1890, p. 16, R. 1891, p. 14*) the diet did not affect the relative proportion of fat and lean meat.

In two experiments at the New York Cornell Station (*B. 2, B. 8*) the proportion of lean meat was appreciably greater in the lambs fed on the nitrogenous diet.

In four out of the five experiments referred to above a nitrogenous ration caused a more rapid gain in live weight than a carbonaceous ration.

At the Wisconsin Station (*R. 1891, p. 14*) wethers fed on a nitrogenous ration gave slightly more washed and unwashed wool. This wool lost more in washing than that from the lot fed on a carbonaceous diet.

In two of the New York Cornell Station experiments (*B. 2, B. 8*) the nitrogenous food produced more wool than the carbonaceous food.

Cotton-seed meal vs. linseed meal for lambs.—At the Wisconsin Station (*B. 32*) one lot of lambs, 3 months old, received a grain ration of one part, by weight, of cotton-seed meal and two parts of corn meal. Another lot had linseed meal substituted for the cotton-seed meal. Both lots were in a pasture together. The average weekly gain made by the lot on cotton-seed meal was 2.95 pounds, and by the lot on linseed meal, 3.3 pounds per head.

Rape as a food for sheep.—At the Minnesota Station (*B. 20*) 4 sheep and lambs were pastured on rape, while a similar lot received timothy hay. The lot on rape gained one-fourth of a pound per day for each animal, the other lot one-eighth of a pound per day per head. One acre of rape was found to be equal to nineteen-twentieths of a ton of hay.

Silage and roots for fattening sheep.—At the Michigan Station (*B. 84*) the average gain of each lamb fed on grain, hay, and sugar beets was 3 pounds per week; when fed on grain, hay, and corn silage the weekly gain was 2.5 pounds. Estimating roots and silage at the same price, roots proved slightly more economical.

In an experiment at the New York Cornell Station (*B. 47*), when corn silage was compared with mixed hay as forage for lambs, 4 pounds of silage was found about as effective as 1 pound of hay.

In two experiments at the Utah Station (*B. 17, B. 19*) there was found in the carcasses of sheep fed on roots or silage a larger per cent of water than where dry food had been used.

Winter rations for breeding ewes.—At the Wisconsin Station (*R. 1891, p. 5*) a lot of ewes were fed on cut corn fodder at $1 per ton; another lot on oat straw at $3; and a third lot on blue grass hay at $8 per ton. Each lot received like amounts of oats, bran, and sugar beets. The ewes were fed not for fattening, but for maintenance. Each lot made a small gain. The corn fodder ration cost for each animal 1 cent per day; the straw ration 0.8 cent; the hay ration 1.2 cents per day. Oat straw thus proved the cheapest coarse fodder, and hay the most expensive.

In another experiment at the same station (*R. 1891, p. 9*) the cost, with current prices in Wisconsin, of the daily ration of each ewe was with corn silage 1.1 cents, with clover silage 1.3 cents, with sugar beets 1.2 cents. Clover silage was eaten with avidity. The report states that sugar beets are inferior to clover silage and corn silage, and that beets are apt to induce scouring if fed in quantities of over 4 pounds daily to each ewe.

Shearing wethers in winter before fattening them.—On December 12 three wethers were shorn at the Wisconsin Station (*R. 1891, p. 23*) and a similar lot left unshorn. Both lots were fed alike till April 20, when both were sheared. The twice-shorn lot yielded a total of 28.5 pounds of unwashed wool, while the single shearing of the other lot afforded fleeces weighing 32.7 pounds.

The twice-shorn lot gained in flesh 107.9 pounds and the other lot 110.7 pounds. Hence when wethers were wintered in a shed whose average temperature was about 35° F., shearing twice was not advisable.

In a similar experiment on lambs, the Ontario (Canada) Station (*B. 68*) found practically no difference in the gain of flesh made by lambs shorn late in November and those not shorn.

Breeding.—At the Wisconsin Station (*R. 1891, p. 33*) lambs with two top crosses of the Shropshire on Merino ewes could not easily be distinguished from those of pure Shropshire breeding.

A similar cross gave satisfactory results at the South Dakota Station (*R. 1890, p. 15*), the cross-bred animals retaining, in large measure, the fleece of the Merino, and the size, fecundity, hardiness, and "mutton quality" of the Shropshire.

Sheep, foot rot.—Opinions differ somewhat concerning this disease. By some two forms are recognized, sporadic and contagious, while others consider them the same, differing only in degree.

The sporadic or noncontagious disease may be produced by foreign substances getting between the hoofs and causing inflammation of the space between them. If not checked the whole foot will become involved and the hoof will drop off. The same result comes from putting sheep accustomed to high pastures upon low, mucky ones. Their hoofs grow too long and afford opportunities for collection and adhesion of materials causing decay and the subsequent inflammation. Usually the front feet are the first to be affected, and examination will show them to be inflamed, hot, and feverish. Remove all superfluous horn from the hoof, cleanse thoroughly, and apply butter of antimony to the inflamed part. In twenty-four hours, if the wound is foul and still discharging, apply again. Keep the feet clean by washing with water containing either blue vitriol or copperas, one part to twelve parts of water. One part of carbolic acid to 150 of water may be added. The animal should be carefully looked after and fed.

In the contagious form the cause is said to be a specific poison, which may be introduced into a flock in various ways from infected stock. Lameness will be noticed in one or more feet, the foot will be found swollen above the hoof, and the spaces between the claws will be red and tender. In a few days small pimples, containing a watery fluid, will be developed. In a week or two proud flesh appears and the hoof begins to separate. At the end of about a month the hoof drops off. The disease spreads from foot to foot until all are involved, and the animal lies down to die of starvation. The specific virus oozes from the sores in the feet and may be spread in various ways. The cars in which sheep are transported are often infected.

Whenever the disease appears among sheep they should be divided at once into three lots—the infected, suspected, and unaffected. In this way they may be better treated. The treatment is the same as for the noncontagious form. New stock if not well known should be quarantined for two or three weeks. (*La. B. 10, 2d ser.; Mich. B. 74; N. Dak. B. 3.*)

Sheep, gid or staggers.—A disease due to a form of one of the tapeworms of the dog (*Tænia cœnurus*), which becomes located in the brain or spinal cord of the sheep. The sheep become infected by pasturing where eggs of this tapeworm have been scattered by dogs. The dogs in turn are infested by eating the brains of sheep containing cysts. The symptoms in the sheep are stupor and involuntary muscular movement. The pupil of the eye usually becomes fixed and the sight or hearing is impaired. There is no inclination for food and the animal loses flesh rapidly. If the parasite be located in the side of the brain the animal will turn its head to one side, and is liable to walk in a circle. If located near the middle the movements will be irregular and jerky. Sometimes the breathing is very difficult, due to the location of the cyst in the medulla, which is the center of the nerves controlling respiration. If the cyst is located at the top of the head the skull over the cyst will enlarge and become soft in about a month. The cyst may then be removed through the operation of craniotomy.

The brains and spinal cords of sheep which have died with this disease should be burned or buried so deep as to be out of the way of dogs. Wolves, coyotes, and foxes are also capable of spreading the infection. (*La. B. 10, 2d ser.*)

Sheep, head scab.—A disease caused by a minute parasite, *Sarcoptes scabiei*. Under a magnifying glass these parasites may be recognized by their rounded, somewhat oval bodies, the adult having four and the young three pairs of legs. They usually begin their attack on the upper lip, but may be found about the eyes, ears, or any part of the body that is but partly covered with wool. They burrow under

the skin and cause an irruption to break out. This forms a scab and spreads until more or less of the head is involved. The constant scratching and rubbing of the head is often one of the first symptoms. This is often continued until blood flows from the broken skin. This disease is easily prevented, as an application of almost any of the ointments or dips known to sheepmen will stop it if applied when the trouble first appears. If the scab has formed it must be softened and removed with oil or grease before the remedy is applied. The presence of this parasite will cause a loss in the poor condition of sheep and small yield of wool. The parasites are transmitted in various ways, and immediate treatment should be given them, since they increase with amazing rapidity. (*N. Dak. B. 3; S. Dak. B. 25.*)

Shepherd's purse.—See *Weeds.*

Shorthorn cows.—See *Cows, tests of dairy breeds.*

Silage [also written Ensilage].—Green fodder preserved in air-tight pits or boxes (see *Silos*). The practice of making silage was introduced into this country from France less than twenty years ago. The use of silage has been greatly extended through the reports of investigations and other information on this subject disseminated by the stations.

Corn is the crop most extensively used for silage, but many varieties of saccharine and non-saccharine sorghum, pearl millet, alfalfa, soja bean, clover, cowpeas, rye, and other forage crops are sometimes preserved in the silo.

VARIETIES FOR SILAGE.—*Minn. R. 1888, p. 90,* states that though Southern Ensilage corn in Minnesota produces twice as much fodder as the Minnesota Dent, Leaming, Sibley's Pride of the North, etc., yet the higher nutritive value of the medium-sized dent corn and the saving in labor in handling the crop render these latter varieties preferable for Minnesota. In later experiments (*Minn. B. 7*) the dent varieties yielded the most fodder and more dry matter than either flint or sweet varieties.

At the Wisconsin Station (*B. 19, R. 1889, p. 123*), in 1889, Southern Horse Tooth gave the largest yield of green fodder, of protein, and of sugar. In 1888 Southern Horse Tooth gave the largest yield, followed by Southern Ensilage.

At the Kansas Station, in 1888, White Flat Ensilage and Southern Horse Tooth were the best of 7 varieties. In 1890 Mosby's Prolific afforded the largest yield. The Burrill and Whitman is a standard silage corn and produces heavily.

Of sixteen varieties grown at the Vermont Station (*R. 1889, p. 89*) the Wisconsin Yellow and Pride of the North did best.

The New York Cornell Station (*B. 16*) found that the flint varieties contained a larger per cent of dry matter than either the sweet or dent varieties. The dents gave the largest amount of dry matter.

The yield of sorghum is often greater than that of corn. The latter has the further advantage of remaining green later in the fall, thus prolonging the season of filling the silo (*Kans. B. 6*).

At the Alabama Canebrake Station the silage from Kaffir corn was not readily eaten by cattle.

The tangled condition of the cowpea vines makes much labor necessary in harvesting and cutting (*Ala. Canebrake B. 9*). The small farmer who can not afford to buy a silage cutter has in pea vines a crop which can be successfully ensiled without cutting, though ordinarily it is better to cut the vines intended for silage.

At the Wisconsin Station (*R. 1888, p. 85*) clover silage kept in perfect condition. Cows ate it with relish and gained in milk. Analyses at that station showed that clover silage is much richer in protein than corn silage.

COMPOSITION.—For composition of silage from different plants see *Appendix, Tables I and II.*

CULTURE AND STORAGE.—The culture of crops intended for silage does not differ essentially from that desirable for the same crops grown for fodder. As the result of numerous experiments it is now held that corn for silage should be planted thin enough for considerable grain to mature. There is still considerable diversity of

opinion as to the proper time for harvesting the crop, though recent investigations seem to favor greater maturity than was formerly thought desirable. Chemical analyses recently made at the New York Station indicate "that for the greatest amount of nutriment, considered from a chemical standpoint, corn should not be cut before it has reached the milk stage of the kernel." In Ohio it is recommended by the station that "fodder corn should be cut when the corn begins to glaze and when the stalks begin to dry near the ground." But in Kansas, where intense heat and other climatic peculiarities hasten the ripening of the crop, it is thought that harvesting "should not be delayed after the corn is in the early dough state."

It is now quite generally thought better to put both stalks and ears in the silo than to use the stalks alone for silage. Before being placed in the silo the corn should be cut into small pieces. Some experimenters prefer one-half inch lengths, as these will pack more evenly and solidly than longer pieces. It is a good practice to keep a man in the silo while it is being filled to see that the silage is packed as closely in the corners and along the sides as elsewhere. If the filling occupies much time, so that the silage becomes heated, some of the cooled silage near the sides should be from time to time thrown into the center and replaced with the warmest silage, so as to keep the temperature of the whole mass as even as possible. It seems to make little difference whether the filling is continuous or extended over several days, provided the work is carefully and thoroughly done. There is no agreement among experimenters as to the necessity of weighting the silo. At the Ohio Station a wooden cover made of flooring boards well fitted together was placed on the silo. On this was placed about a ton of sand in boxes, and round the edge of the cover next the silo walls a piece of inverted sod to prevent the entrance of air. After the silage had settled about 2 feet a ton of grass was thrown over the boxes of sand. In Kansas a layer of tarred paper, covered about 18 inches deep with green grass, has been as effectual as weighting heavily with rocks.

Fermentation in the silo.—Investigations by Prof. Burrill, of the Illinois Station (*B. 7*), emphasize and help to explain the fact that silage is necessarily a very variable product, requiring careful treatment. The corn or other material used for silage varies in maturity, in chemical composition, and in amount of moisture. Numerous and diverse chemical changes take place in the silo, and the fermentations due to the action of the minute organisms classified as yeasts, bacteria, and molds, are varied and complex. Until very recently people have had but little idea of the influence of bacteria and other ferments in the operations of the farm. Much remains to be found out concerning their action in the silo, for studies in this line are only just begun.

The kinds of ferments which cause changes in the silo include (1) yeasts, which cause the change of sugar into alcohol and other fermentations; (2) bacteria, which cause the formation of acids and the heating in the silo, and which appear to aid in the destructive changes, notably the semi-putrid decomposition, accompanied by bad odors, so often occurring in old silage; and (3) molds which also cause putrefaction. The yeasts found in the silo do not appear to be such as cause ordinary alcoholic fermentation, and it is doubtful if ordinary alcohol occurs in silage. The hot fermentation which often takes place soon after the silo is filled, though not yet fully explained, is not due to yeast. Two or more species of bacteria appear to be concerned in the raising of the temperature. These bacteria are similar to those which cause butyric fermentation, *i. e.*, the formation of butyric acid in rancid butter. The high temperature does not destroy the bacteria and molds, which later cause acid fermentation and putrefaction. After the heating, however, the silage settles and the air is excluded. The initial high temperature which these bacteria induce is, therefore, probably most serviceable by causing this closer packing of the silage and the exclusion of the air, rather than by killing the germs of other ferments.

Ferments which induce the formation of acetic acid in vinegar and of lactic acid in milk are active in the silo, and if allowed to act produce much acid and make

the silage sour. Silage from corn, however treated, contains the acid originally is the stalks. "Sweet silage" is that which has in addition only a small quantity of the acids formed by fermentation. What commonly passes for sweet silage is not always the same thing. It may be obtained either with or without great heat. By the process of rapid filling and close packing, especially with the more mature and dry corn, the mass remains sweet, simply because little fermentation of any kind taken place in the silo. If, on the other hand, the silo is filled slowly, the mass soon becomes very hot. This high temperature is due to the action of bacteria. After the heating, the silage settles and the air is excluded. In this way fermentation is largely prevented and the silage remains comparatively sweet. Since air and moisture favor the fermentations which injure silage, it follows that mature corn containing less water than that cut earlier, and close packing in an air-tight silo, are needed to produce the best silage.

The losses in dry matter of corn from ensiling as compared with field curing have been investigated at several stations. The results on the whole indicate that when both processes are carefully carried on under ordinary conditions the losses are likely to be less in ensiling than in field curing (*Mich. B. 49; Pa. R. 1890, p. 43; Wis. R. 1890, p. 97*). Prof. Sanborn, however, contends that in his experiments in Missouri and Utah the advantage has been on the side of field curing (*Mo. B. 7; Utah B. 8*).

Silage, value as food.—Silage has been tested extensively at the stations as a food for all kinds of farm animals, and generally with favorable results. The animals take to it readily as a rule, and it often has the effect of sharpening their appetites and inducing them to relish large quantities of food.

Better results have usually followed when it has been fed in connection with some other coarse fodder, as clover hay. As a rule it has been found a cheaper food than hay for dairy cows or growing animals.

The Ohio Station (*B. Vol. II, 3*), fed silage successfully to horses, calves, and pigs, as well as to dairy stock. The horses were given one feed of 20 pounds of silage per day instead of hay during February and March. With this ration their appetite was sharpened and the spring coat of hair was glossy.

The Pennsylvania Station (*R. 1890, p. 118*) states, as the result of actual estimates that "a good average corn crop has produced with us from one and one-third to two and one-quarter times as much food per acre as a good hay crop." Concerning the amount of food furnished when the corn is ensiled and when field-cured, the Pennsylvania Station (*R. 1889, p. 113*) estimated the amounts of digestible food nutrients in silage and in field-cured corn fodder from one acre. The figures were based on actual yields of corn and on digestion coefficients found in trials with steers. The results are here given:

Digestible ingredients in fodder corn from one acre.

	Green fodder corn.	Silage.	Field-cured fodder corn.
	Pounds.	*Pounds.*	*Pounds.*
Albuminoids	184	82	133
Non-albuminoids	67	151	69
Carbohydrates	3,947	3,164	3,030
Fat	153	263	156
Total digestible	4,351	3,660	3,388

These amounts are equivalent to the amount of digestible food materials contained in from 3 to 4 tons of average timothy hay.

Experiments on the relative digestibility of silage and corn fodder from the same

corn have been reported as follows: *N. Y. State R. 1884, p. 45; 1889, Pa. R. 1889, p. 123, R. 1890, p. 50; Wis. R. 1888, p. 28, R. 1889, p. 69.*

The results of these experiments differ considerably with the kind and maturity of the corn used, the conditions under which the corn was cured or ensiled, etc. As a rule, however, it is believed that they indicate silage to be slightly more digestible than dry corn fodder.

The Pennsylvania Station (*R. 1890, p. 60*) found that sheep digested from 14 to 15 per cent less of the dry matter, fiber, and nitrogen-free extract, and only half as much of the protein of silage as steers.

A trial with one sheep at the Oregon Station (*B. 6*) indicated that cooking silage diminished the digestibility of its protein and slightly increased that of crude fiber and nitrogen-free extract.

Feeding experiments with silage are mentioned below, and also under *Sheep* and *Pigs*.

(*Iowa B. 6, B. 13; Mass. State B. 37, B. 41; Minn. B. 7; Nebr. B. 17; N. H. B. 9, B. 14; N. Y. State B. 84, R. 1890, p. 364; Wis. R. 1884, p. 11, R. 1886, p. 34; Vt. R. 1889, p. 51.*)

SILAGE FOR MILK AND BUTTER PRODUCTION.—This subject embraces comparisons of corn silage (1) with corn fodder, (2) with hay, and (3) with roots.

Silage vs. dry corn fodder.—The Wisconsin Station has made experiments for six years to compare the value of corn silage and dry corn fodder for milk and butter production (*R. 1886, p. 25, R. 1888, p. 5, R. 1889, pp. 69, 130, R. 1890, p. 80, R. 1891, p. 49*). In these experiments the corn fodder has not been allowed to stand long in the field after cutting but has been kept under cover. Both the silage and corn fodder have constituted a larger proportion of the ration than would ordinarily be the case in practice to obtain the maximum difference in the effect of these fodders. As a rule the cows relished the silage and thrived upon it. The results of the comparison of the two foods have not always been uniform from year to year, but they have never been at all pronounced in favor of either food. The silage has sometimes given a slightly larger quantity of more watery milk than the corn fodder; and in other experiments this result has been reversed.

In other experiments a larger yield of both milk and fat on silage has been accounted for by the fact of the cows having eaten more silage than corn fodder. But when the results of the six years are summarized the conclusion is that "properly cured corn fodder and corn silage of similar variety and maturity are of equal value for milk and butter production." In several experiments the silage was found to possess a somewhat higher rate of digestibility than the corn fodder.

Regarding the relative amounts of milk and butter produced from silage and corn fodder grown on equal areas of land the Wisconsin Station (*R. 1891, p. 49*) reports an experiment made to test this point in which 20 cows were fed the product from nearly 6 acres.

"Summarizing our work in this line, we have the following conclusions:

"(1) A daily ration of 4 pounds of hay and 7 pounds of grain feed, with corn silage or field-cured fodder corn *ad libitum*, fed to 20 cows during sixteen weeks produced a total quantity of 19,813.4 pounds of milk during the silage periods and 19,801.2 pounds of milk during the fodder-corn periods.

"(2) When we consider the areas of land from which the silage and fodder corn fed were obtained, we find that the silage would have produced 243 pounds more milk per acre than the dry fodder, or the equivalent of 12 pounds of butter. This is a gain of a little more than 3 per cent in favor of the silage."

The New Jersey Station (*B. 19*) found that (1) the loss of food ingredients was less in the stack than in the silo; (2) cut and crushed corn fodder was eaten by cows quite as readily and with as little waste as silage; (3) in three out of four cases there was no increase of milk on silage; and (4) with one herd there was an increased yield of total solids in the milk during the silage period, and with the other no increase.

In a trial at the Michigan Station (*B. 47, R. 1889, p. 205*) cows gave somewhat more milk on dry corn fodder than on silage, but the silage lasted longer than the corn fodder from a similar area, although nearly a quarter of the silage spoiled. The tendency seemed to be to gain in live weight on silage feeding rather than to produce milk.

A trial at the Missouri Station (*B. 8*) was favorable to dry corn fodder. "Dry fodder corn for cows proved more effective, especially dried sugar corn, than silage. Cows fed on dry fodder corn gave the richest milk, the best butter, which seemed to keep better, and maintained their live weight best."

In a comparison of a number of different coarse foods, the Vermont Station (*R. 1889, p. 51*) found corn fodder and corn silage from the same source to give practically like results per pound of dry matter eaten, although average silage proved superior to average corn fodder, and both were superior to corn stover. "Good corn silage caused gain in all respects over good hay," and "hay and corn stover had much the same effect on milk production."

In a later series of experiments at the same station (*Vt. R. 1891, p. 75*) the yield of milk was larger on silage than on corn fodder, but the milk was of poorer quality on silage, containing 12.91 per cent solids and 4.05 per cent fat on an average, while it averaged 13.25 per cent solids and 4.28 per cent fat on corn fodder. The total yield of milk constituents (fat, etc.), was slightly higher on silage. Considering the yield of milk and butter fat on silage and corn fodder from like areas of land, the result was favorable to silage, showing that on it 8 per cent more milk, 5 per cent more solids, and 3 per cent more fat were produced than on corn fodder. A pound of dry matter in silage produced more milk and slightly more solids and fat in six out of nine cases than a pound of dry matter in corn fodder. The loss of dry matter was 20 per cent in ensiling and 19 per cent in field curing in shocks, but the loss of albuminoids was largest in field curing. The result of this comparison of corn fodder and silage agreed practically with that at the Wisconsin Station.

At the Pennsylvania Station (*R. 1890, p. 79*), while more milk was produced on silage than on corn fodder, it was of poorer quality, so that the total yield of butter fat was slightly larger on the corn fodder. Pound for pound of dry matter, more milk and more solids were produced on the silage ration. "The greater efficiency of the silage ration was due to the greater digestibility of the silage."

Silage vs. hay.—Experiments were carried on at the Massachusetts State Station for five years (1885–'89) to compare corn fodder, corn stover, and corn silage with good English hay for the production of milk. (*Mass. State R. 1885, p. 10, R. 1886, p. 11, R. 1887, p. 11, R. 1888, p. 11, R. 1889, p. 12.*) The effect of these feeding stuffs was studied on the yield and composition of the milk, the total and net cost of the milk per quart, and the physical condition of the animals. These coarse foods were invariably fed in connection with a grain ration. Silage was usually fed with some hay; corn fodder and stover were usually fed alone with the grain ration. The valuation used in calculating the cost of food per quart of milk was the same in all experiments, *i. e.*, hay, $15; corn fodder, $5; corn stover, $5; and silage, $2.75 per ton; and in calculating the net cost 80 per cent of the value of the fertilizing ingredients of the food was deducted from the first cost, it being assumed that 80 per cent of the fertilizing ingredients can be recovered in the manure. The corn fodder, stover, and silage were usually fed cut or shredded. The corn fodder was cured in the field and was invariably cut at the same stage as the silage—usually when the kernels were beginning to glaze.

First, concerning the effect of these fodders on the cost of milk production, the results of the experiments showed that in every instance the cost was highest when hay was fed alone. Whenever a part of the hay was replaced by either corn fodder, stover, or silage the cost was materially reduced, often as much as one-half cent per quart of milk. When corn fodder, stover, or silage were fed alone (with grain) the cost was likewise reduced, and between these three fodders, at the prices charged,

little uniform advantage could be traced. In general, their ability to reduce the cost depended upon the extent to which they replaced the hay.

As to the comparative value of these fodders for food, Prof. Goessmann says that, pound for pound of dry matter, they have proved "fully equal, if not superior, to average English hay." At the close of the fifth year of experiment he says: "To produce a quart of milk, using the same quantity and quality of grain food, required in every instance a larger quantity of perfectly dried hay than of either corn fodder, corn stover, or corn silage in a corresponding state of dryness. Corn silage was most advantageously fed in place of one-fourth to one-half of the full hay ration. From 35 to 40 pounds of silage per day, with all the hay called for to satisfy the animal (in addition to the grain ration), seems a good proportion." The fodders compared well as far as quantity and quality of milk and of cream was concernd.

The Maine Station (*R. 1889, p. 69*) found that when one-third of the hay (mostly timothy) was replaced by silage a somewhat higher milk yield was maintained for sixty-three days than on hay exclusively (preceding period) with practically no change in the composition of the milk. This was not due to a larger amount of digestible food being eaten while on silage than on hay.

The Minnesota Station (*R. 1888, p. 112*) compared timothy hay and silage made from large southern varieties of corn, replacing the hay entirely by silage. The silage was sour and the cows "did not eat enough of the ration to either maintain the flow of milk or to keep from falling off in weight. * * * The hay and grain ration produced an unusual and undesirable increase in live weight."

In a trial at the Vermont Station (*R. 1890, p. 86*) "silage gave less milk than hay, the quality being the same;" and corn fodder gave less milk of slightly poorer quality than hay.

At the Wisconsin Station (*R. 1884, p. 11*) corn stover fed uncut was compared with mixed hay and with clover hay. Fed in this way there was a considerable loss of stover, and it was found to be equivalent to about one-third of its weight of mixed hay or somewhat less than one-third of its weight of clover hay.

According to the New Hampshire Station (*B. 13*) "hay apparently produced a harder butter than silage," but the relative yield on the two foods is not stated.

Silage vs. roots.—Experiments covering several years have been made at the Massachusetts State Station (*R. 1886, p. 11, R. 1887, p. 11, R. 1889, p. 12*). In these the cost of food per quart of milk was higher with sugar beets at $5 or carrots at $7 per ton than with silage at $2.75 or corn fodder at $5 per ton. In feeding value, however, Dr. Goessmann states that the roots were fully equal if not superior to silage, pound for pound of dry matter. Both root crops almost without exception increased the temporary yield of milk, exceeding, as a rule, the corn silage in that direction. It is suggested that from 25 to 27 pounds of roots per day be fed in place of part of the hay.

The Ohio Station (*B. Vol. II, 3, B. Vol. III, 5*) reports two experiments made to compare silage and sugar beets for milk production. In both experiments the cost of food per quart of milk was a fraction of a cent less on silage at $2.30 per ton than on beets at $2. These prices are the estimated cost of production of the crops. In 1890 the yield of milk was considerably and in 1889 slightly higher on beets than on silage; but in 1889 the silage showed a greater tendency than the beets to increase the live weight, while in 1890 the cows gained a pound a day in weight on beets and lost a pound on silage. No data are given as to the composition of the milk.

A comparison at the New York State Station (*R. 1890, p. 364*) of mangel-wurzels and silage resulted favorably, financially and otherwise, to the silage. The roots and silage were each reckoned at $3 per ton.

From a comparison of roots and silage at the Pennsylvania Station (*R. 1890, p. 79*) the inference was that roots were slightly inferior to silage, more digestible matter being required per pound of milk solids or fat than on silage.

Silage for beef production and growth.—A silage composed of corn, sorghum, and soja bean, with a nutritive ratio of 1:10.3, proved at the Maryland Station

(*B. 8*) to be "a good and sufficient food for two-year-old heifers during the winter, just before first calving and at time of calving. It was more than a maintenance ration in this trial." About 40 pounds of the silage were fed per animal per day.

During the winter of 1887–'88 the Wisconsin Station (*R. 1888, p. 63*) compared the gain from silage alone and with a grain ration of shelled corn and bran, using two-year-old and three-year-old steers. The silage used contained very little grain.

The steers on silage made an average gain of 1.5 pounds per day and those on silage and grain of 3.7 pounds per day. To make 100 pounds of gain in weight the silage lot ate 3,558 pounds of silage, and the other lot 654 pounds of silage, 394 pounds corn, and 181 pounds bran. Hogs, following the grain-fed steers, required only 92 pounds additional corn to make 100 pounds of gain.

The Texas Station (*B. 6*) found that a ration of silage and boiled cotton seed produced a very cheap and rapid growth.

Silage vs. dry corn fodder.—From a number of experiments which have been made, it appears that equal weights of dry matter in silage and in well-cured corn fodder are about equally effective for beef production. The relative advantage of the two foods depends upon the cost, the amount of food secured, convenience, weather at harvesting, palatability, quantity eaten, etc., rather than on any marked difference in the efficiency or digestibility of the dry matter. The Pennsylvania and Texas Stations found silage the more palatable, while at the Utah and Iowa Stations corn fodder, was more eagerly eaten than silage. It is generally conceded that, as a rule, silage is the more palatable and that rather more dry matter will be eaten in a silage ration.

(1) *Steers.*—At the Missouri Station (*B. 8*) the amount of dry matter eaten per pound of increase in weight was 13.72 pounds on a silage ration and 15.79 pounds on a corn-fodder ration. The silage-fed steers made the larger gain in live weight. On the basis of the gain per pound of dry matter fed, therefore, the result was slightly in favor of the silage; but on the basis of the gain per pound of dry matter harvested the advantage was with the corn fodder, for it is estimated that for every pound of gain by the steers there was put into the silos 23.11 pounds of dry matter as against 16.97 pounds of dry matter made into corn fodder. In feeding, the silage gave out sooner than the corn fodder from a similar area.

The Utah Station (*B. 8*) reports a comparison of silage with cut corn fodder which is interpreted as unfavorable to the silage system in Utah. The silage was from nearly ripe corn cut when "the leaves and husks were turning yellow," and was eaten sparingly by the steers. There was practically no gain on either food. Analyses showed that the carcasses of animals fed on silage averaged 74.17 per cent of water, and those fed on corn fodder 68.4 per cent.

In an experiment at the Pennsylvania Station (*R. 1890, p. 79*) when the rations of silage and corn fodder from the same corn were each fed with a grain ration, "the corn fodder and silage were eaten equally clean, and the amount of food eaten per pound of grain was substantially the same for both rations." The daily gain of the silage lot (3 steers) was 4.23 pounds or 1 pound for every 12.9 pounds of dry matter eaten; and of the corn-fodder lot 4.27 pounds, or one pound for every 12.55 pounds of dry matter.

At the Texas Station (*B. 10*) "dry corn fodderdid not give as large gain as silage," when each was fed with cotton-seed products. While 53 per cent of the corn fodder was rejected by the animals, only 8.2 per cent of the silage was refused. (*Iowa B. 6; Minn. B. 4.*)

(2) *Heifers.*—A comparison of silage and corn fodder, fed *ad libitum* with a grain ration, was made on two Jersey heifers at the New York State Station (*R. 1888, p. 297*). The silage was readily eaten and there was a marked increase in weight on it, but on corn fodder there was either only slight gain in weight or no gain at all.

In a similar comparison at the Illinois Station (*B. 9*) the results, as shown by the gain in weight and the dry matter consumed per pound of gain, were not very conclusive. One lot was fed silage and the other corn fodder the first two periods, and

he third period both lots were fed corn fodder. The gain in weight per pound of dry matter eaten was in favor of the silage in the first period, and of corn fodder in the second period, so that at the end of the second period the results with the two averaged about equal. In the third period, however, when both lots were fed on corn fodder, the difference was decidedly in favor of the lot fed continuously on corn fodder, making the average for that lot for the whole time slightly better than for the silage lot.

(3) *Sheep.*—Sheep did not readily eat the silage used in a trial at the Utah Station (*B. 8*). They gained 26 pounds on silage and grain, as compared with 30 pounds on corn fodder and the same grain ration.

Silage vs. hay.—Concerning the relative merits of corn silage and hay of good quality, a trial with steers at the Maine Station (*R. 1889, p. 75*) showed that, pound for pound of digestible matter, the gain was slightly larger on silage than on timothy hay, although the difference was small. One pound of hay was equal in effect to about 4 pounds of silage.

Acid silage gave inferior results as compared with good hay at the Iowa Station (*B. 6*), but sour silage was not eaten readily in large quantities.

With silage at $2.50 and hay at $10 per ton, the Virginia Station (*B. 10*) found silage the cheaper food. The cost of coarse food and grain per 100 pounds of gain in weight was $8.20 on the silage ration and $11.20 on the hay ration. (*Va. B. 3; Ohio B. Vol. II, 3; Ontario Agr. College R. 1890.*

Silage vs. roots.—The Michigan Station (*B. 84*) reports a comparison of silage and sugar beets on 16 lambs, feeding each material in connection with hay and a grain ration. On an average 4.7 pounds of beets or 4.4 pounds of silage were eaten daily per lamb. The average weekly gain was 3 pounds while on roots, and 2½ pounds while on silage. The results are held to indicate that "roots are superior to silage for fattening lambs." (*Va. B. 3; Ontario Agr. College R. 1890.*)

Silage from different materials.—Very few feeding trials with other than corn silage have been reported.

A rather inconclusive trial at the Iowa Station (*B. 6*) failed to show any essential difference between the feeding value and palatability of corn silage and sorghum silage made from a mixture of amber and orange cane cut when ripe. By mixing nearly mature soja beans and green corn fodder in equal parts, the Massachusetts State Station (*B. 41*) produced a silage much richer than corn silage, the dry matter comparing well in composition with red clover hay.

The Maryland Station (*B. 8*) fed two pure-bred Ayrshire heifers, both with calf, for about two months exclusively on silage composed of corn, sorghum, and soja beans. The silage "proved to be more than a maintenance ration in this trial."

In a comparison on ten milch cows at the Vermont Station (*R. 1891, p. 86*) "clover silage did not do as well as corn silage."

The Minnesota Station (*B. 7*) compared silage from southern corn and flint corn on milch cows and on fattening animals. The value of the two appeared about equal for milk, pound for pound of dry matter, but the southern corn produced about one-third more dry matter in the silage per acre. For fattening cattle flint-corn silage gave the best returns per acre, due, it is believed, to the larger amount of well-ripened ears it contained.

The Vermont Station (*R. 1889, p. 51*) found poorly made silage from frost-bitten corn inferior to that well made from corn not frosted.

The Illinois Station (*B. 16*) ensiled apple pomace successfully, but pigs refused to eat much of it.

At the Vermont Station (*R. 1889, p. 51*) apple-pomace silage was relished by cows, and when fed as a partial substitute for corn silage "appeared by four tests to be about equivalent in feeding value to corn silage."

The same station found Hungarian-grass silage inferior to corn silage. It was "on the whole, of nearly equal value with good hay."

An attempt to ensile turnips (*Vt. R. 1891, p. 88*) resulted disastrously.

Apple-pomace silage: *Mass. State R. 1891, p. 320; Vt. R. 1887, p. 88.* Brewers' grain silage: *N. J. R. 1880, p. 46, R. 1884, p. 107.* Clover silage: *N. J. R. 1881, p. 55, R. 1883, p. 75; Vt. R. 1887, p. 88, R. 1891, p. 86; Wis. R. 1886, p. 99, R. 1888, p. 85, R. 1889, p. 145, R. 1890, p. 215.* Cowpea silage: *Ala. Canebrake B. 9; Mass. State R. 1890, p. 134; N. C. R. 1882, p. 138; Tex. B. 6; Vt. R. 1887, p. 88.* Sorghum silage: *Ala. Canebrake B. 9; Tex. B. 10, B. 13; Vt. R. 1887, p. 88.* Sugar-cane-bagasse silage: *Tex. B. 6.*

(*Ark. R. 1890, p. 5; Conn. Storrs R. 1888, p. 96; Ill. B. 2, B. 7; Iowa B. 16; Kans. B. 18, R. 1888, p. 67, R. 1889, p. 64; Md. R. 1889, p. 105; Mich. B. 68; Minn. B. 2, B. 8; Miss. R. 1888, p. 30; Nebr. B. 17; N. H. B. 3, B. 10; N. J. B. 11, R. 1882, p. 79, R. 1889, p. 142; N. Y. Cornell B. 4; N. Y. State B. 9, B. 85, R. 1882, R. 1887, p. 73, R. 1889, p. 80; N. C. B. 80; Ohio B. Vol. II, 3, B. Vol. III, 3; Ore. B. 9; Pa. B. 7, B. 11, B. 15, R. 1888. p. 34, R. 1889, p. 35; Tex. B. 6, B. 10, B. 13, R. 1888, p. 66.*)

Silk oak.—See *Grevillea*.

Silos.—The first silos were shallow pits in the earth; afterwards these pits were lined with masonry. Heavy weighting naturally found a place in shallow silos, but has become less popular since the depth of the pits has been increased. The most serious inconvenience from these underground silos was the difficulty of getting out the silage for feeding. This difficulty was partially obviated by building an addition of wood on top of the stone silo, by which arrangement a part of the silage was stored above ground. It was observed that wooden walls preserved the food as perfectly as stone and brick. With improved carriers it was not difficult to elevate the cut forage 15 or 20 feet, and the custom of building wooden silos wholly above the ground became general. Now wood is generally recognized as the best material for silos, and is much cheaper than brick or stone.

Location.—Since silage is heavy food, the silo should be so located that the contents need to be carried but a short distance to the animals. Where the cattle stand in two rows with an alley between, it is frequently most convenient to have the silo in one end of the barn with its door just opposite this alley, so that the track for the hand car used in feeding may be perfectly straight.

In order to have the silo as near the cattle, and to make its construction as cheap as possible, it is recommended to build the silo in the barn. A root cellar is frequently used as a silo by taking out the floor above and building a wooden wall to the height of the barn plates.

A silo at the Maryland Station was built as a "lean-to" against the cattle shed. If it is not convenient to make the silo a part of the barn, it should be located near by and in such position as to communicate easily with the feeding alley.

Among the stations which have published descriptions of silos are Alabama, Arkansas, Illinois, Kansas, Maryland, Michigan, Minnesota, Missouri, Mississippi, New Hampshire, New York State, North Carolina, Ohio, Oregon, and Wisconsin.

Several attempts to preserve green food without the expense of building a silo are on record. The Mississippi Station (*B. 8*) piled into a round and compact heap about 8 tons of green chicken corn and covered it with earth. Except the upper 3 or 4 inches it was perfectly preserved.

The Kansas Station (*R. 1889, p. 64*) made in a corn field an excavation 30 feet long, 15 broad, and 2½ deep. The stalks of corn were put in whole and rolled with a heavy iron roller. Four inches of straw and 20 inches of earth were put on. There was practically no loss from rotting.

The New York State Station (*R. 1888, p. 326*) made two small stacks of silage. A temporary roof was erected and pressure was applied to the stacks by means of chains and levers. The loss was about 50 per cent of the whole.

Material.—Wood is by far the cheapest material for the silo. Stone or brick is seldom used except when it is desired to utilize standing walls of masonry. At the Kansas Station nearly 50 per cent of the material stored in stone silos spoiled.

Though the experience of others has not been so disastrous, yet many have observed that silage is better preserved next to a wooden wall than near a stone wall. In silos examined by the Wisconsin Station no such difference was observed.

The silo lining and the outer coat which protects the silo frame from the weather are usually sufficient to prevent any serious freezing of the silage. In the South there is no danger of freezing, and the silo lining is sufficient, except that the sides exposed to the weather must be battened or weatherboarded to protect the framework. Only the soundest lumber should be used in building a silo, and as far as possible arrangements should be made to secure ventilation for frame and lining.

FLOOR.—A wooden floor is seldom used. The cheapest floor consists of pounded clay raised a few inches above the surface of the ground outside. A coat of cement is frequently applied to the floor. As a safeguard against the entrance of rats through the floor the bottom of the silo may be covered with a layer of small stones or grout before the coat of cement is applied.

FOUNDATION.—The stone or brick walls on which the sills rest should extend at least 6 inches above the silo floor and 8 inches above the ground outside. The sills should be anchored to the wall with iron rods. By having the sills 2 inches narrower than the studding, a 2-inch shoulder on the stud prevents the lining of the silo from fitting tight against the sill, and thus allows for the silo to be ventilated. The sills may consist of two pieces spiked together, each 2 by 8 inches or 2 by 10 inches.

These should be painted with coal tar and bedded in mortar, crossing at the corners.

STUDDING.—Studs smaller than 2 by 8 inches are rarely used, even though the height of the silo is only about 12 feet. In practice, 2 by 10 inch material is generally used when the length is not over about 16 feet and the distance between studs 18 inches. For greater lengths 2 by 12 inch material is safer. The following table is an extract from a table given in *Wis. R. 1891, p. 260*. The purpose of the investigation was to calculate the pressure which white pine studs of different sizes and lengths would sustain without excessive bending, and then to calculate the actual force which the silo contents would exert on these studs at time of filling the silo. (For data when studs are 6, 8, 9, 10, 12, 16, and 24 inches apart see *Wis. R. 1891, p. 260.*)

Safe pressure, total actual pressure, and amount of bending of studs of given sizes, in rectangular silos, white pine.

Depth of silo.	Size of studding.	Safe total pressure.	Studs 18 inches apart.	
			Total actual pressure.	Bending.
Feet.	*Inches.*	*Pounds.*	*Pounds.*	*Inches.*
16	2 by 8	1,733	2,112	....
	2 by 10	2,708		0.78
18	2 by 10	2,408	2,673	1.40
	2 by 12	3,467		0.81
20	2 by 12	3,120	3,300	1.37
22	2 by 12	2,836	3,993	....
24	2 by 12	2,600	4,752	....

The data given in the table apply most closely to the studs nearest the centers of the sides, the actual pressure being less toward the corners. The table indicates that 2 by 10 inch studs, 16 feet long, bent 0.78 inch, and 18 feet long, 1.40 inch; while 2 by 12 inch studs 18 feet long bent only 0.81 inch.

Studs are nailed to the sills at distances of 14 to 24 inches apart, usually 16 or 18 inches apart, and are held in place at the top by a strong built-up plate. No corner posts are necessary, but the two studs at the corner are set about 2 inches apart and

perpendicular to each other in such a manner that every other horizontal lining plank may be nailed to the narrow edge of the one and then to the broad side of the other. In this manner from bottom to top of the silo the ends are securely tied together by the lining. For the round silo, where the diameter does not exceed 30 feet, the Wisconsin Station considers 2 by 4-inch studding, 1 foot apart, strong enough. Most of the outward strain is sustained by the horizontal lining, which may be half-inch lumber, and by the siding protecting the frame, which may also consist of half-inch lumber.

Lining.—Some wooden silos have been lathed and plastered. The springing of the walls causes cracking, and the acids of the silage render the plaster liable to destruction and permit the laths and woodwork beneath to become damp and to rot. The Wisconsin Station lined one silo with sheet iron and one with tin. Neither was satisfactory. One very unsatisfactory paper-lined silo is on record. Shingles have been used, but this material is not recommended. The usual lining consists of two thicknesses of boards, breaking joints, with a coat of tarred paper between the layers of boards. When the frame consists of horizontal girths both courses of plank may be put on vertically. Otherwise the first layer is put on horizontally, and the inner layer either horizontally, breaking the joints of the first, or vertically. A coat of tar is sometimes applied between the two courses of boards.

To preserve the silo lining from decay a coat of hot coal tar, coal tar dissolved in gasoline, linseed oil, paraffine, or other material is sometimes applied to the surface which comes in contact with the silage.

The Wisconsin Station examined a number of silos with painted lining and found but little advantage in the paint. A perfectly impervious coat would be effective, but as heretofore applied there have been left numerous places for silage juices to enter the wood; this may hasten the rotting by keeping the boards just damp enough for the growth of fungi and by preventing the quick drying of boards after the silage is removed. The boards for lining need not be matched, but should be edged or jointed so as to fit together tightly. Smoothness of the silo walls is essential.

The Wisconsin Station advises painting both layers of boards on one side only with hot coal tar boiled until it is not sticky when cold. The tarred sides should then be placed face to face, with paper between.

Corners.—Silage spoils worst in the corners where it settles poorly. Hence sharp corners in the silo should be avoided. This can be done by nailing in the corner a vertical board with beveled edge, or by diagonally splitting a large square piece of lumber for the corner long enough to extend from floor to plate. Or the corner may be boxed off by boards 2 or 3 feet long, papered, and reboarded like the other parts of the silo.

Doors.—The best silos have doors almost continuously from the floor to the top of the wall. The space between two studs, or between two such spaces, is used as a doorway. The door may consist of sections of the double course of boards cut from this space, with tarred paper between the boards. These section doors make a lap joint against the studs or lining, so that when a strip of paper is tacked along the line of joining the joint is practically air-tight. They may be hung on hinges, though this is not necessary, for the pressure of the silage holds them rigidly in place.

Ventilation.—The method of securing ventilation between the lining and the sill has been mentioned under *Foundation*. In the lowest plank of the outer lining of the silo auger-holes may be bored between each two studs, and the outer lining does not come to the plate at the top by nearly 2 inches; this permits the circulation of dry air between the walls of the silo, and thus retards rotting of the wood. These ventilators should be covered with wire netting, and in extremely cold weather may be closed by boards.

Roof.—The form of roof is not important. It should contain a ventilator, and

over the plates space must be left or a window provided for the carrier which conveys the silage into the silo.

DIMENSIONS.—The smallest per cent of waste occurs in deep silos. The Wisconsin Station recommends a depth of at least 24 feet, though many good silos are only about 20 feet deep. Silos 36 feet deep are on record, but the framing for silos of such great depth necessarily differs somewhat from that of the ordinary silo. A silo whose length and breadth are equal is more economical than a long narrow silo. A round silo will contain the maximum amount of silage for a given outlay in lumber.

A silo may have one or more partitions, and this becomes necessary when the number of cattle is not sufficient to eat daily the silage from the entire upper surface to a depth of about two inches. Unless two or three inches of silage is fed out daily over the whole surface, there may be some waste from molding. Feeding from the entire upper surface is the proper method. In calculating the size of silo necessary for a given time and number of cattle, one cubic foot per animal, with some concentrated food, may be considered as a full daily ration.

COST.—The New Hampshire Station estimates the cost of a 40 to 70 ton silo built in the barn at $1 per ton of capacity for lumber, labor, and all material, or less if the materials are on the farm. The Kansas Station places the cost of a wooden silo at $2 per ton of storage capacity. A silo at the Maryland Station, constructed as a "lean-to" against a cattle shed, and having a capacity of 90 tons, cost $2.63 per ton. At the Missouri Station a stone silo of 90 tons capacity cost $453, while the estimate for a wooden silo of the same size was $292.

The Wisconsin Station compares the cost of a rectangular wooden silo 14 by 24 feet inside with that of a round wooden silo of 20 feet inside diameter. Both silos are of the same capacity, 200 tons, and of the same depth, 30 feet. Detailed estimates are given, which for the rectangular silo amount to $425.08 and for the round silo to $246.59, or about $2.12 and $1.25 per ton respectively.

(*Ala. Canebrake B. 9; Ark. R. 1889, p. 68; Fla. B. 16; Ill. B. 2; Kans. B. 6, R. 1888, p. 95; R. 1889, p. 64; Md. R. 1889, p. 95, R. 1890, p. 101; Mich. B. 47, B. 68; Minn. R. 1888, p. 85; Mo. B. 7; Miss. B. 8; Nebr. B. 17; N. H. B. 1, B. 14, R. 1888, p. 14; N. Y. State R. 1888, p. 326; N. C. B. 80; Ohio, Vol. II, 3; Ore. B. 9; Wis. B. 19, B. 28, R. 1888, p. 10.*)

Sisal hemp (*Agave sisalana*).—A tropical or subtropical fiber plant, which now grows wild in Florida, having been introduced in 1836 or 1837. The leaves are not cut till the third or fourth year, but after that time the plantations continue in bearing for many years. The yield per acre is stated to be about half a ton of cured fiber. (*Div. of Statistics, U. S. D. A., Fiber Investigations, R. 3.*)

Skim milk.—See *Milk.*

Skirret (*Sium sisarum*).—A vegetable now little planted, but formerly grown for its tuberous roots, which were used in much the same way as parsnips. Attempts were made to grow the skirret at the New York State Station (*R. 1884, p. 287*), which succeeded only by planting the seed in boxes in the hotbed and transplanting. The seeds in all cases failed to vegetate out of doors.

Soiling.—The system known as soiling consists in feeding animals in the barn during the growing season largely or wholly on green forage crops, instead of pasturing them. The system finds more extensive application as the value of land increases. Its advantages are that less land is required to maintain a given number of animals, the food supply can be better regulated, the animals do not waste their energy in searching for food, and the manure can all be saved and applied to the soil. The arguments for partial soiling are that the amount of feed furnished by pastures is very irregular, being unusually abundant and of good quality early in the season, but falling off later from droughts or early frosts. Unless some supplementary food is given at such times the milk flow diminishes and the cows fall off in flesh.

Concerning the relative amounts of food furnished by the two systems, the Pennsylvania Station found in experiments in two years (*R. 1888, p. 54, R. 1889, p. 53*) that "in round numbers we can produce from three to five times as much digestible

food per acre by means of the soiling crops (rye and corn or clover and corn) as is produced by pasturage such as is represented by our small plat." The plat in question was believed to fairly represent the average pasture. From feeding trials with the above soiling crops and pasture grass the average yield of milk per acre was calculated as follows:

Yield of milk per acre of land.

	1888.	1889.
	Pounds.	*Pounds.*
Soiling	3,416	5,671
Pasturage	928	1,504
Difference	2,488	4,167

It will be understood that the above is only an estimate, but it points very strongly in favor of the soiling crops.

Similar comparisons at the Wisconsin Station (*R. 1885, p. 19*), using an upland blue grass pasture and green clover, oats, and cut corn fodder, resulted as follows: In four months the cows used produced per acre of land 1,779 pounds of milk and 82 pounds of butter on pasturage; and 4,782 pounds of milk and 196 pounds of butter on soiling crops, a large balance in favor of soiling. Prof. Henry concludes from this result that "it is fair to state that by soiling in summer a certain area of land will yield double the amount of milk and butter that it will when pastured." He recommends partial soiling in summer to bridge over the time when the pastures are short and insufficient.

The Iowa Station (*B. 15*) compared pasturage in "one of the best blue grass pastures in the State" with soiling with green peas and oats, green oats and clover, and clover and green corn fodder, respectively. The cows gave more milk on soiling crops, gained more in live weight, and were less annoyed by flies than when on pastures. "The cow responds as promptly to a well-balanced ration of grain while eating green feed as she does on dry feed."

The Massachusetts State Station has conducted experiments with soiling crops since 1887 (*R. 1887, p. 35, R. 1888, p. 38, R. 1889, p. 48, R. 1890, p. 39, R. 1891, p. 59.*) In these the soiling crops used have included vetch and oats, cowpeas, serradella, soja beans, and corn fodder, all fed green and in connection with grain rations and usually with hay. The result has invariably been highly favorably to the soiling crops as compared with hay. By replacing about three-fourths of the hay by soiling crops the yield and quality of milk have been maintained and sometimes improved, and the cost has usually been reduced.

In the last experiment reported (1891) the largest yield of milk was on green soja beans and dried brewers' grains; and green corn fodder proved superior to green vetch and oat fodder.

The Connecticut Storrs Station (*B. 9*) maintained 4 cows from June 1 to November 1 on a little less than 2½ acres of soiling crops with the addition of a very light grain and straw feed.

By a judicious selection of soiling crops not only can a much larger number of cows be kept on a given area of land, but the land may be brought into a higher state of cultivation and fertility, and much grain may be spared. The leguminous crops, as clovers, cowpeas, vetch, alfalfa, etc., are especially valuable for soiling purposes. These plants are unusually rich in nitrogenous food ingredients, which are essential in feeding animals and which otherwise have to be furnished largely in grains. This class of plants has been found to possess the faculty of taking their nitrogen very largely from the atmosphere. (*See leguminous plants.*) They thus require little manuring with nitrogenous manures, which are the most expensive manures the

farmer has to buy. They furnish anitrogenous food for animals, which, when fed, enriches the manure in nitrogen, and they also improve the physical condition of the soil and enrich it by the stubble and roots which they leave behind. Their more extensive use by farmers is to be strongly recommended.

In soiling it is important to have a succession of green fodders throughout the growing season, with each in its best stage of growth for feeding. There should be no breaks in the succession and each crop should be used as nearly as possible at the time when it contains the largest amount of valuable food constituents.

From three years of experience and observation in the practice of soiling, the Connecticut Storrs Station (*R. 1891, p. 13*) suggests the following series of crops for soiling in central Connecticut:

Crops for soiling in central Connecticut.

Kind of fodder.	Amount of seed per acre.	Approximate time of seeding.	Approximate time of feeding.
1. Rye fodder .... bushels..	2½ to 3	Sept. 1	May 10-20.
2. Wheat fodder .... do....	2½ to 3	Sept. 5-10 ...	May 20-June 5.
3. Clover .... pounds..	20	July 20-30 ..	June 5-15.
4. Grass (from grass lands)	....	....	June 15-25.
5. Oats and peas (each) .... bushels..	2	Apr. 10	June 25-July 10.
6. Oats and peas (each) .... do....	2	Apr. 20	July 10-20.
7. Oats and peas (each) .... do....	2	Apr. 30	July 20-Aug. 1.
8. Hungarian .... do....	1½	June 1......	Aug. 1-10.
9. Clover rowen (from 3)	....	....	Aug. 10-20.
10. Soja beans .... bushels..	1	May 25	Aug. 29-Sept. 5.
11. Cowpeas .... do....	1	June 5-10...	Sept. 5-20.
12. Rowen grass (from grass lands)	....	....	Sept. 20-30.
13. Barley and peas (each) .... bushels..	2	Aug. 5-10 ...	Oct. 1-30.

The gains of steers on pasturage, soiling crops, and dry hay, representing similar areas, were compared at the Utah Station (*B. 15*). The soiling crops consisted of alfalfa, timothy, and red clover, and the hay was made from a mixture of the same. During the three months of feeding, the gains made by the three lots were practically identical, but the pastured lot consumed the product from more than a quarter larger area than the lot on soiling. The dry matter eaten per pound of gain in live weight is calculated as 15.7 pounds on pasturage, 12.4 pounds on soiling crops, and 13.8 pounds on hay.

Soils.—The act of Congress making appropriations for experiment stations provides "that, as far as practicable, all such stations shall devote a portion of their work to the examination and classification of the soils in their respective States and Territories, with a view to securing more extended knowledge and better development of their agricultural capabilities;" but, although quite extensive investigations have been made in a few States, no systematic concerted work in these lines has been done by the agricultural experiment stations of the country. At a conference of representatives of the agricultural colleges and experiment stations in Washington, August, 1891, a resolution was adopted asking that the work of the Weather Bureau of the Department of Agriculture "be enlarged to include the physics, conditions, and changes of agricultural lands." One result of this action has been the commencement of the publication of a series of bulletins by experts on this phase of meteorology which, it is hoped, will serve the purpose of enlisting in the study of the subject "a larger number of active workers and observers, so that at least the large amount of information actually existing may be gathered together and made practically useful, thus leading the way to a better understanding of the character, capabilities, and needs of the lands of the various regions, and of the

means of utilizing them to the best advantage" (*U. S. Weather Bureau B. 3*). In view of the renewal of interest in this subject, Prof. Milton Whitney, of Maryland Station, who is engaged in a systematic study of the soils of Maryland, briefly outlines in *E. S. R., vol. III, p. 665*, various problems in soil physics which might be profitably studied by the various experiment stations.

In this article work of the experiment stations on soils will be discussed under the following heads:

(1) Origin, formation, classification.
(2) Chemical composition and properties.
(3) Physical properties and mechanical analysis.
(4) Reclamation and renovation.

Origin, formation, classification.—Soils are broken and decomposed rock, with a small admixture of animal and vegetable remains. "We find in nearly all soils fragments of rock, recognizable as such by the eye, and by the help of the microscope it is often easy to perceive that those portions of the soil which are impalpable to the feel chiefly consist of minute grains of the same rock" (Johnson, *How Crops Feed, p. 106*). Whitney has recently proposed for the clay group of soil particles heretofore classed as impalpable the limits of 0.005—0.0001 mm. diameter, that is, the smallest grain of clay is about $\frac{1}{25400}$ inch in diameter (*Md. R. 1891, p. 276*).

The agencies which have reduced rocks to soil are: Changes of temperature; moving water or ice; chemical action of water and air; and influence of vegetable and animal life. Since these agencies are continually at work in the soil, its physical and chemical properties are constantly changing.

Soils are geologically classified according to mode of formation or deposition. The U. S. Geological Survey proposes the following tentative classification:

Endogenous soils, derived from country rocks and remaining in place.

Exogenous soils, derived from other sources than the country rocks proper to the districts where the soils are situated.

In practice soils are simply classified as gravelly, sandy, loamy, clayey, calcareous, etc., distinctions being based in the majority of cases simply on the fineness of the particles, or the relative proportion of sand and clay. According to Stockbridge (*Rocks and Soils, p. 147*),

Sandy soils contain 80 per cent or over of sand.
Sandy loams contain 60–75 per cent of sand.
Loams contain 40–60 per cent of sand.
Clay loams contain 25–40 per cent of sand.
Clay soils contain 60 per cent or over of clay.

The classification of the soils peculiar to the individual States wherever made has generally been due to the State geological surveys, and in most of the older States at least these have been quite complete. A few of the stations have undertaken or planned systematic agricultural or soil surveys, viz, those of California, Georgia, Louisiana, Maryland, Mississippi, New Jersey, Oregon, and South Carolina.

The work of the California Station has included the collection and examination of a large number of soils and subsoils from the various agricultural and geological sections of that State, as well as other States; the origin, nature, distribution, and reclamation of alkali lands; the examination of artesian, lake, and river waters, with a view to their utilization for irrigation, and a comparative study of the soils of humid and arid regions (showing the relations of climate to soil). (See *Cal. R. 1890, App.*, and *U. S. Weather Bureau B. 3.*)

The plan followed in this work has been "to attain as far as resources permit, first, a full knowledge of the occurrence, location, extent, natural peculiarities, and climatic position of each prominent variety of soil, by examination in the field, at the same time eliciting by inquiry from those cultivating it whatever of information they may possess as to the soil's merits, peculiarities, or adaptations" (*Cal. B. 26,*

1877). At the same time representative samples have been taken and submitted to analysis (both chemical and mechanical). The number of samples thus examined approaches a thousand.

In Georgia work has been confined to a general geological study of the soils of the State (*B. 2*) and a special investigation of the "Southern Drift" as found in Georgia (*B. 6*).

The Louisiana Station has undertaken a comprehensive geological and agricultural survey of the State, the first report on which relates to the geology of the hills of North Louisiana. "Soils have been classified and carefully mapped out, typical samples taken, character of vegetation noted, drainage systems established, and general elevations above sea level, with other special peculiarities" (*Specal R. on Geol. and Agr., part I*).

Under the auspices of the Maryland Station, Johns Hopkins University, and the U. S. Department of Agriculture, Prof. Milton Whitney has continued on Maryland soils a line of investigation commenced on North Carolina and South Carolina soils. (*N. C. R. 1886, p. 92, R. 1887, p. 161; S. C. R. 1889, p. 44; Md. R. 1891, p. 249.*)

His conclusions regarding the formation and classification of the former are as follows:

"The texture or the relative amount of sand and clay contained in the soil resulting from the disintegration of rocks will depend upon the kind of rock—that is, upon the minerals of which it is composed. A thorough and detailed geological map of the State should answer for a soil map. Any one familiar with the texture of the soil, or kind of soil formed by the disintegration of granite, gabbro, and the different kinds of limestones, sandstones, and shales, should be able to tell by a glance at the map the position and area of each kind of soil. Each color on the map would represent a soil formation of a certain texture, in which the conditions of moisture under our prevailing climatic conditions would be best adapted to a certain crop."

For the purpose of determining the general characteristics of the soils of the State as indicated by their origin and agricultural value, a large number of samples of soils and subsoils were collected in different parts of Maryland. "These samples have been arranged in groups according to their agricultural value and their geological origin, and equal weights of the samples in each group have been mixed together, forming a composite sample representing the *type* of the soil formation."

It appears that all of the principal agricultural regions of the State are represented by about ten types. These are designated pine barrens, market truck, tobacco, wheat, river terrace, grass, mountain pasture, etc. It is found from analysis that these types are further characterized by the number of soil particles per gram, there being a steady increase in size of soil grains from the pine barrens up to grass lands.

"From the mechanical analysis of the samples which were used to make up these type samples and perhaps of a large number of other soils of known agricultural value, it should be possible to determine the smallest and the largest number of grains per gram of soil where these different crops could be successfully grown. For example, no crop can be successfully grown except under highly artificial conditions of manuring with organic matter or by irrigation, on a soil having so few as 1,700,000,000 grains per gram. Good market truck is grown on a soil having 6,800,000,000 grains. * * * Good wheat is grown on a soil having 10,000,000,000 grains per gram, and this must be near the limit of profitable wheat production, for 8,000,000,000 grains per gram gives a soil rather too light for wheat, but well suited to tobacco. A soil having 10,000,000,000 grains per gram is too light for grass, which thrives on a limestone soil having 24,000,000,000. Our type soils should therefore show the range for the profitable production of a given crop. We should be able also from the mechanical analysis of an unknown soil to give it its true agricultural place by reference to these established soil types."

In *N. J. R. 1888, p. 213*, there is given a popular discussion of the origin and formation of soils, and a classification of New Jersey soils proposed by the State geological survey, as follows:

Granitic soils	Clay district soils
Limestone soils	Drift soils
Slate soils	Marl-region soils
Red sandstone and shale soils	Tertiary soils
Trap-rock soils	Alluvial soils.

An agricultural survey of Oregon has been planned by its station (*B. 13*). The State has been divided on the basis of climatic conditions into six sections, the method followed in general being that used extensively in California (see above).

A systematic study of the soils of South Carolina was undertaken under the auspices of the experiment station, but the investigation did not extend beyond the collection and examination of a number of the soils typical of the rice and sea island cotton region (*S. C. R. 1889, p. 11*) and of the soils of the station farms representing three different sections of the State.

In *Wyo. B. 1* there is given a brief account of the geology of the Laramie Plains. The author places this region in the Triassic formation, and not in the Dakota group as is done by the United States Geological Survey.

Chemical composition and properties.—Since plants derive their ash constituents exclusively from the soil, it is evident that in order that a soil may produce plants it must hold all these ash constituents in proper proportion and in assimilable condition. Those elements which are of especial agricultural significance are chlorine, sulphur, carbon, silicon, potassium, sodium, calcium, magnesium, iron, aluminum, manganese, and phosphorus. Soils, as we have seen, are the result chiefly of the decomposition of rocks. Now, since rocks contain all the simple bodies or elements known to science, there is little likelihood of any soil being entirely deficient in any of the necessary elements of plant food. Their proportion and availability, however, may vary so widely as to cause wide differences in productiveness.

It has been questioned whether chemical analysis affords reliable indications of the productiveness of a soil. The value of this method of examination of soils is thus succinctly stated by G. E. Morrow, of the Illinois Station (*Soils and Crops, p. 37*): "An examination of a soil by a chemist will show with great exactness of what it is composed and the relative proportions of the elements. It may show that there is evidently a too small supply of some essential ingredient, or it may show that there is some substance or some combination present which will be injurious to plants. In these ways such an examination may give most valuable suggestions as to manuring the soil or other methods of improving its fertility. A chemical analysis, however, will not show with certainty whether the substances of which the soil is composed are in condition to be available as plant food. Often it gives very little help to an understanding of whether or not the soil is in good physical condition. The chemist is able to state not only the actual and relative quantity of each element found in the soil, but also the percentage of this which is soluble in water and soluble in acids. This information helps greatly in estimating the quantity of each which is probably in suitable condition to be taken up and used by plants."

After thirty-five years' study of this question on a great variety of soils, Prof. Hilgard (*Cal. R. 1889, p. 163*) concludes that "in no case has any natural virgin soil showing high plant food percentages been found otherwise than highly productive under favorable physical conditions, * * * but the reverse is not true, viz, that low plant food percentages necessarily indicate low productiveness." Improved physical conditions in the latter case may more than make up for the deficiency of plant food. "It is then absolutely indispensable that both the physical character, as to penetrability, absorptive power, etc., of a soil should be known, as well as its depth above bed rock, hardpan, or water, before a judgment of its quality, productiveness, and

durability can be found from its chemical composition." One kind of examination is the necessary complement of the other.

The processes by which soils are formed and plant food rendered available are constantly going on in the soil, so that both the chemical and physical conditions of soils are constantly changing, and frequent examinations are necessary if we are to be accurately informed as to the chemical and physical properties of any soil at any given time.

In actual chemical analysis only the fine earth (never larger than 1 mm. in diameter, preferably ½ mm. according to Hilgard) is examined, it being assumed that this fine earth contains all the plant food readily or immediately available to plants.

This fine earth is submitted to digestion with acids which separate it into two parts—an insoluble residue which affords an approximate measure of the sandiness of the soil, and a soluble portion which is further examined.

The minimum percentages of the different mineral elements in soils which chemical analysis has found to be necessary to the thrifty growth of general crops is summarized as follows from *Cal. R. 1889, p. 165*, and *Ore. B. 21:*

Potash is one of the three elements which exert a marked influence on the productiveness of soils, but is capable of great variation without materially affecting the productiveness of the soil. In heavy clay uplands it ranges from 0.8 to 0.5 per cent; in lighter loams from 0.45 to 0.30; in sandy loams below 0.30; and in sandy loams of great depths may fall below 0.10, with good productiveness and durability. "No virgin soil having 0.50 per cent of potash will wear out first on that side of its store of plant food; and much less will suffice in the presence of much lime and humus" (*Cal. R. 1889, p. 166*). In California soil the percentage of this ingredient may run as high as 1.80 per cent.

Lime exerts a potent influence on both the chemical and physical quality of a soil. High sandy soils average about 0.10 per cent; clay loams 0.25 per cent; heavy clay soils 0.30 per cent., and the percentage may rise with advantage to 1 or 2 per cent. Calcareous soils are characteristic of arid regions. Lime is quite readily dissolved in soil water and therefore accumulates in lowlands and subsoils. It is a conserver of humus, and its carbonate especially is valuable for the decomposition of silicates.

Magnesia appears to exert little direct action in the soil and is seldom deficient.

Manganese appears to be of no special significance.

Iron is always present in abundance. It "rarely falls below 1 per cent, and more commonly ranges from 2 to 5 per cent." Ferric soils possess increased absorptive power for heat and moisture (*S. C. R. 1889, p. 13*).

The percentage of alumina "conveys little information as to the character of a soil."

Sulphuric acid in the best soils is slight—0.02 per cent is adequate—but frequently rises to 0.10 per cent.

Phosphoric acid depends for its effectiveness largely on the proportion of lime present. One-tenth per cent is usually sufficient for productiveness when accompanied by a fair supply of lime. It rarely runs higher than 0.30 per cent.

Humus is of special interest since it is largely the source of the nitrogen supply. "In the loam (oak) uplands of the cotton States the percentage of humus seems to range usually between 0.70 and 0.80 per cent; in the poorer sandy (pine) soils, 0.40 to 0.50 per cent; in the black, calcareous, prairie soils, from 1.20 to 2.80 per cent. The determinations made there are not, perhaps, sufficiently numerous to give fair averages. "In California (and in the arid region generally) the humus percentages, as might be foreseen, average somewhat lower; lowest in light loam soils of the high mesas of Southern California, where 0.30 per cent, and even less, has been found; yet these soils produce well at first, when irrigated. Percentages of 0.45 to 0.60 of humus are common in good upland soils that are neither very calcareous nor highly ferruginous. The "prairie," or black adobe soils usually range from 1.20 to 1.80 per cent—a very few as high as 3. On the whole, the highly ferruginous soils are remark-

able for large amounts of humus, as in the red soils of the foothills and of the coast range."

In *U. S. Weather Bureau, B. 3*, Prof. Hilgard collates in tables analyses of soils from the arid and humid regions of the United States, omitting analyses of soils from limestone regions. These tables bring out the fact that soils of the arid regions are rich in lime and zeolites (complex easily decomposable silicates of lime, soda, potash, and alumina), and all essential elements of plant food, and deficient in clay and insoluble matter; in other words, they are very fertile. They are also of great depth, being in many cases practically devoid of what is known in humid regions as subsoils.

For a discussion of the nature of those soils found in regions of deficient or irregular rainfall, which are impregnated with soluble alkali salts, see *Alkali soils*.

The method of chemical analysis used by Peter, Hilgard, Smith, and Loughbridge, in their work for the Tenth Census, is described in *S. C. R. 1889, p. 19*. For methods adopted by the Association of Official Agricultural Chemists, see report of meeting August, 1892 (*Div. of Chemistry, U. S. D. A., B. 35*).

PHYSICAL PROPERTIES AND MECHANICAL ANALYSIS.—The physical properties of soils which are of special importance are color, weight, fineness of division or texture, adhesiveness, and relations to gases, heat, moisture, and dissolved solids.

To variations in these different properties is largely due the varying productiveness of soils.

Prof. Whitney, of the Maryland Station, concludes, as a result of his studies in this line, that "the local distribution and development of plants are largely dependent upon the circulation of water within the soil and the ease with which the proper water supply may be maintained within the soil for the crop, and upon the relation of the soil to heat. Soil exhaustion is due to a change in the arrangement of the soil grains, changing the relation of the soil to moisture and heat. The chief value of commercial fertilizers and manures is in their physical effect on the texture of the soil or the arrangement of the soil grains, which changes the relation of the soil to moisture and heat." (*E. S. R., vol. III, p. 665.*)

Physical properties of soils are determined largely by the proportions which they contain of stones, gravel, sand, clay, lime, and organic matter. The relation of the more important of these ingredients to physical properties of soils is thus explained by Prof. Morrow, of the Illinois Station (*Soils and Crops, p. 39*): "Sand is heavy; is usually light colored; the grains do not stick together. It has little power of attracting moisture from the air, and allows water to run through it readily. It absorbs and retains heat well. A soil with much sand in it will be dry and warm; easy to work; not sticky; will not "bake." In dry weather crops on such soils will suffer from lack of moisture. Soluble plant food will leach through such a soil.

"Clay, or a soil with much clay, has a fine texture, and the particles adhere tenaciously. It absorbs moisture from the air readily, draws water from below by what is known as capillary power, and holds it well. This tends to make such a soil cool, but it will absorb heat readily. It absorbs and holds ammonia and other gases readily. If stirred while wet it becomes hard; often cracks in drying. It differs much in color. The presence of iron will give a red color. Commonly it is a light yellowish color. Clay soils usually have more plant food than sandy ones; they hold moisture better, and there is less loss of soluble manures or available plant food by leaching. They are hard to work, and are often too cold and wet unless well drained. They "heave" as the result of freezing and thawing.

"A mixture of sand and clay makes a better soil than one almost entirely composed of either. The addition of clay to sand makes it more tenacious; enables it the better to absorb and hold moisture and gases; gives it greater capillary power; enables it to withstand drought better, and, usually, will make it cooler. The addition of sand to clay makes it more easily penetrable by the roots of plants; more easy to work; somewhat warmer; less injured by being worked when wet; less apt to "heave."

"Humus, or decayed vegetable matter, in soils makes them light in weight and dark in color; greatly increases their power to absorb moisture from the air and their capillary power; makes clay soil less and sandy soil more compact. It will be seen that, aside from its value as a source of plant food, humus is important in improving the physical condition of the soil. Most soils containing much humus are fertile, if not too wet.

"Lime in soils has a considerable importance aside from its use as food for plants. It improves the texture by making clay soils more easily worked and sandy soils more compact. It hastens the decay of vegetable matter." (See also *Cal. R. 1889, p. 151.*)

From what has been said the importance of the mechanical analysis of soils is evident. In mechanical analysis the particles composing soils are separated in different grades of fineness usually six in number, as follows:

	Diameter.
	Millimeter.
Coarse sand	0.5 to 1.0 ($\frac{1}{25}$ inch).
Medium sand	0.25 0.5
Fine sand	0.10 0.25
Fine dust	0.05 0.10
Silt	0.01 0.05
Clay	less than 0.01

Since the size of the soil particles exerts such a marked influence on the physical properties of soils it is very important to be able to accurately and easily determine the proportion in each grade of fineness. Some process of elutriation is generally employed for this purpose. Two methods proposed by American investigators require special notice as making distinct advances on all previous methods—the churn-elutriator method of Prof. E. W. Hilgard (*Amer. Jour. Science and Arts, October and November, 1873; Conn. State R. 1886, p. 150*), and the beaker-elutriation method of T. B. Osborne (*Conn. State R. 1886, p. 144*).

In the first of these a current of water, the movement of which can be controlled at any desired velocity, is made to flow through a cylinder containing the weighed amount of soil, thus carrying along particles of a certain hydraulic value, while flocculation is prevented by a rapid churning of the lower column of the water by means of a special device.

In the second method the separations are accomplished by stirring up the soil with water in beakers and decanting. Microscopic examination is mainly relied on to determine the thoroughness of the separations.

Both these methods have been thoroughly tested, and discussions of their relative merits and of various proposed modifications, etc., will be found in *Cal. R. 1889, p. 158; Conn. State R. 1886, p. 150, R. 1888, p. 154.*

The method of sampling employed at the California Station is described in *Cal. R. 1889, p. 155;* that used at the South Carolina Station in *S. C. R. 1889, p. 11;* that used at Wisconsin Station in *Wis. R. 1890, p. 160.*

The value from an agricultural standpoint of the chemical and mechanical analysis of soils is discussed in *Cal. R. 1889, p. 151.*

Weight of soil.—According to Schübler the weights of 1 cubic foot of various soils are as follows:

	Pounds.
Dry siliceous or calcareous sand	110
Half sand and half clay	96
Common arable soil	80 to 90
Heavy clay	75
Garden mold rich in vegetable matter	70
Peat soil	30 to 50

"From the above figures we see that sandy soils, which are usually termed 'light,' because they are worked most easily by the plow, are, in fact, the heaviest of all; while clayey land, which is called 'heavy,' weighs less, bulk for bulk, than any other soils, save those in which vegetable matter predominates. The resistance offered by soils in tillage is more the result of adhesiveness than of gravity. Sandy soils, though they contain in general a less percentage of nutritive matters than clays, may really offer as good nourishment to crops as the latter, since they present one-half more absolute weight in a given space. Peat soils are light in both senses in which this word is used by agriculturists." (Johnson, *How Crops Feed, p. 158.*)

Texture of soils.—The productiveness of a soil depends to a considerable extent upon its texture. The latter determines largely the circulation of water and gases, the solution and retention of plant food, and the growth of plant roots.

A large number of small pores in a soil would enable a soil containing a small percentage of plant food to produce fair crops. It is therefore desirable to thoroughly pulverize the soil, and it is to this end that tillage or cultivation is practiced. A soil, however, may be too fine, and thus subject to puddling or impacting when improperly tilled (see *Clay*).

The texture of soils is markedly affected by various fertilizers; for instance, lime and some other substances have the power of flocculating soils and thus rendering them porous, while certain substances, such as ammonia, urine, etc., have a tendency to keep the particles separate and thus make soils close. (See *Clay* and *Lime.*) These phenomena are explained in *Md. R. 1891, p. 257,* and *S. C. R. 1889, p. 64,* by changes in the surface tension of the soil water.

Relations of soils to heat.—The temperature of the surface soil is subject to the same changes as that of the air, but these changes occur more slowly. The relation of the air temperature to that of the soil at different depths is well shown by experiments at Maine Station (*R. 1891, p. 158*).

"The periods covered by the experiment were from May 1 to November 1, 1889, from April 1 to November 1, 1890, and from April 1, to November 1, 1891, with thermometers placed in the soil [in an open field] to depths of 1, 3, 6, 9, 12, 24, and 36 inches. * * *

"The mean daily range at the depth of 1 inch during the period of observations was 5.55°; at the depth of three inches, 4.77°; at the depth of 6 inches, 2°; at the depth of 10 inches, 1.09°; and below 12 inches inches very slight. * * *

"Comparing soil temperatures with air temperatures during the three seasons, the following mean results appear: At the depth of 1 inch the temperature of the soil was lower than that of the air by 2.16°; at the depth of 3 inches, by 1.89°; 6 inches, by 3.08°; 9 inches, by 3.83°; 12 inches, by 4.06°; 24 inches, by 5.80°; and at the depth of 36 inches, by 7.11°."

There are several modifying influences affecting the temperature of the soil. The first of these is color. A dark-colored soil is usually warmer than a light-colored soil. A soil containing much sand or gravel will heat slowly, but will retain heat longer than one containing much clay or humus. Soils sloping to the south, as is well known, are warmer than those having a northern exposure. Another factor determining the warmth of a soil is its water content. A wet soil is a cold soil. Evaporation is a cooling process, and the heat necessary to carry it on is drawn from the soil. Within certain limits the extent of evaporation is determined by the amount of moisture in the soil (*N. C. R. 1887, p. 196*). Observations on drained and undrained "black slough" soil in Alabama (*Ala. Canebrake B. 6, B. 10*) at depths of from 1 to 36 inches and extending through several seasons, have shown a quite constant though small elevation of temperature in favor of the drained soil—"not enough to benefit vegetation," it is believed. From observations at the Massachusetts Agricultural College (*Special R. 1879*) on cultivated soil and grass land, extending from August to November, no appreciable difference in temperature was found between wet and dry grass land. Cultivated soil was on the average 1.2° C. warmer

when dry than when wet—a smaller difference than is usually assumed. (See also *N. C. R. 1886, p. 109, R. 1887, p. 187.*)

Observations on South Carolina soils (*S. C. R. 1889, p. 74*) lead to the following conclusions: While dry sand tends to become hotter under the same radiant heat than dry clay, practically the tendency is more than offset by the greater evaporation from the sand. It appears that the relation of different soils to heat depends, other things being equal, upon the specific heat of the soil, moisture content, evaporation, and relative surface area of the particles and their arrangement or compactness.

A special form of soil thermometer is described in *S. C. R. 1889, p. 77.*

Other references to work on soil temperatures are: *Colo. R. 1888, p. 220, R. 1889, p. 73, R. 1890, p. 147, R. 1891, p. 73; Mich. R. 1888, p. 31, R. 1889, p. 29, R. 1890, p. 143; Mo. B. 4; Nebr. B. 6, B. 15, B. 17; N. Y. State R. 1889, p. 398, R. 1890, p. 464; N. C. R. 1886, pp. 92, 106, R. 1887, p. 174; Ore. B. 12; Pa. R. 1887, p. 210, R. 1888, p. 177, R. 1889, p. 267, R. 1890, p. 248, R. 1891, p. 247, S. C. B. 7; Utah R. 1891, p. 62; Wyo. R. 1891, p. 85.*

Relations of soils to moisture.—See also *Drainage, Irrigation, Lysimeters.* All soils are capable of absorbing and retaining moisture, but the extent to which this is done varies widely. Investigations at the Wisconsin Station (*R. 1889, p. 196*) show that the upper 5 feet of the soil experimented on was able to store 21.24 inches of water. Thoroughly filled with water, the soil might contain 24.48 inches of water to each square foot of surface, or more than two-thirds of the average annual rainfall. Further investigations (*R. 1890, p. 152*) lead to the conclusion that "the water-holding power of soils, as determined by laboratory methods and generally quoted in standard works on agriculture, is so widely different from the conditions which exist in nature, as shown by field studies, that it becomes utterly misleading when applied in general practice. The highest percentages of water observed in any soils, as taken from the fields at the experiment farm, were: Black marsh soil, 34.71; brick clay, 31.81; clay loam, 33.19; clay loam, 28.88. * * * Laboratory experiments by Trommer have given for similar soils the following percentages: Moor earth, by Zenger, 105; loamy clay, 50; yellow clay, 68; quartz sand with rounded edge, 26."

According to Meister different soils show water holding capacities as follows:

Water imbibed by different kinds of soils.

	Water imbibed.		Water imbibed.
	Per cent.		*Per cent.*
Clay soil	50.0	Chalk soil	49.5
Loam soil	60.1	Gypseous soil	52.4
Humus soil	70.3	Sandy soil (82 per cent sand)	45.4
Peat soil	63.7	Sandy soil (64 per cent sand)	65.2
Garden soil	69.0	Pure quartz sand	46.4
Lime soil	54.9		

The size of the soil particle is of great importance in determining the water-holding capacity. Coarse sand allows water to run through freely, retaining relatively little, while fine clay absorbs and retains a large amount. This question is thus discussed in *Md. R. 1891, p. 282,* from data furnished by examination of type soils of Maryland, already referred to: "The amount of space assigned to these different soil formations has an important bearing on the relative rate with which water will move within the different soils. The coarser-textured soils have less space and will contain less water than the clay soils. The subsoil of the truck land has only 45 per cent of space and will hold but 22.41 per cent by weight of water when this space is completely filled. The subsoil of the Helderberg limestone has 65 per cent of space and will hold 41.22 per cent by weight of water, or nearly twice as much

as the truck land. When the soils contained only 12 per cent of water a quantity of water would move through the truck land in twenty-one minutes which would require one hundred minutes to pass through the subsoil of the Helderberg limestone. When, however, these soils are taxed to their utmost it will take one hundred and forty-one minutes for a quantity of water to pass through the truck land which would go through the limestone subsoil in one hundred minutes. As suggested in a previous section, this undoubtedly explains a matter of common observation and experience, that crops on these light lands are more injured by excessively wet seasons than crops on heavier soils."

The proportion of organic matter is another determining factor, the water-holding capacity increasing as a rule with the increase of organic matter. Good soils will frequently absorb and hold one-half or more of their own weight of water. The most favorable amount of water in the soil is, according to Wollny, from 40 to 75 per cent of its water-holding capacity.

Soil water is constantly in motion. When rain falls the moisture sinks into the soil, carrying along with it oxygen, carbonic acid, nitric acid, ammonia, etc., and rendering plant food available, a part of which may be lost in the drainage if the rainfall is excessive. When the rainfall ceases evaporation commences, and the soil water begins to rise, carrying along with it dissolved plant food which accumulates in the surface soil. This power which soils have of drawing up water from their lower depths is known as capillarity, and may extend down 6 or 7 feet. (*Wis. R. 1891, p. 104.*)

Experiments were conducted at the Connecticut State Station (*R. 1877, p. 83*) to test the effect of depth and fineness of soil on the capillary transmission and evaporation of water. Copper or glass tubes 2 inches in diameter, with perforated metal or cloth bottoms, were filled with calcined and washed emery of different grades of fineness (in case of different tubes 0.0175, 0.0140, 0.0090, 0.0055, and 0.0030 inch in diameter). These tubes were placed in an apparatus which was so arranged as to keep the bottom of the tubes wet, but not to allow evaporation except from the surface of the soil. When the tops of the tubes had become saturated the whole apparatus was weighed. Loss in weight thereafter was taken as a measure of evaporation and capillarity. The columns of emery varied in different cases from 4½ to 14 inches.

From these experiments it appears that the greater the depth of the water table the slower the transmission of water to the surface of the soil. The upward movement of water is easier below than above the limit of saturation of the soil. "The ease with which a soil transmits water upward to supply a loss by evaporation from the surface is greater the coarser the texture of the soil, provided that the height of the soil column is such that the interstices can fill themselves to the tops with water, or, in other words, is not greater than the 'capillary height' of the soil." if among several similar soil columns of different degrees of fineness there are some in which the interstices are full of water to the top and others in which they are not, the greatest ease of upward motion will be found in the coarsest of the first class; that is, a medium fineness will show the greatest transmissive power. When the interstices are full of water to the top and the evaporation is less than the possible supply, the greatest evaporation takes place from the finest soil.

Observations at the Wisconsin Station (*R. 1889, p. 200, R. 1890, p. 139, R. 1891, p. 104*) on the rate and extent of capillary movement of water in soil in its natural condition show that the normal rate of this movement upward, downward, and laterally is not very great, although it may extend to a depth of more than 7 feet. Soils wet nearly to saturation show a more rapid movement of soil water.

Experiments at the New York Station (*R. 1887, p. 103, R. 1888, p. 194*) with different kinds of soils in glass tubes (1⅝ inches in diameter), the lower ends of which were immersed in water, showed marked differences in the height to which the water would rise by capillarity. In muck it was about 23 inches in seven months, in garden

soil about 45 inches in the same time, in sand 20 inches, and in clay 31 inches in about three months, when it ceased to rise. In the first cases it was still rising slowly at the end of a little more than seven months, when observations ceased.

Tubes (60 inches long and nine-sixteenths of an inch in diameter), similarly prepared, but placed in a horizontal position, were used for determining the rate of lateral flow of distilled water, of a saturated solution of nitrate of soda, manure water, muck extract, soil extract, and a solution of common salt. The rapidity of flow was in the following order: Sand, muck, garden soil, and clay. The nitrate of soda solution and manure water decidedly retarded the flow; the muck and garden soil extracts, and salt in proportions of 10 per cent or less promoted it.

The height to which distilled water, manure water, and soil extract rose in capillary tubes 80 to 90 micromillimeters in diameter, was also observed.

The principal results were as follows:

	Specific gravity.	Capillary height (fortieths of an inch).
Manure water	1.010	187.79
Muck extract	1.007	189.00
Garden soil extract	1.007	191.04
Distilled water	1.000	191.67

"It is evident from the figures that the tendency of all the solutions is to lower the height, but the influence is so small as to be practically of little importance." Solutions of wood ashes, sulphate and muriate of potash, nitrate of soda, phosphate of lime, and sulphate of ammonia showed a similar tendency in proportion to their strength.

Investigations similar to the last described have been carried out at the Maryland Station (*R. 1891, p. 253*). From these it is concluded that of the two forces causing movement of soil water—gravity and surface tension—the latter is largely modified by the matters in solutions. Observations on pure water, soil extract, and solutions of salt, kainit, lime, acid phosphate, plaster, ammonia, and urine show that certain of these substances—salt, lime, kainit, etc.— increase the surface tension and thus increase the power of the soil water to draw up moisture from below and keep the soil moist. On the other hand, ammonia, urine, etc., lower surface tension and hinder the capillary flow of water to the surface (See also *S. C. R. 1889, p. 63.*)

Experiments at Wisconsin Station on the effect of barnyard manure on the movement of soil water are thus summarized in *R. 1891, p. 117*: "While the case stands confessedly as one lacking complete demonstration, the evidence in favor of the view that farmyard manure increases the capillary flow of water toward the surface, and thus supplies to crops both water and minerals held in solution by it which would otherwise be unavailable, is both cumulative and thus far positive."

The effect of matters in solution on the texture of soil has already been discussed.

Observations on the fluctuation of the water table (i. e., the level of standing water in the soil) at the Wisconsin Station (*R. 1889, p. 193*) have led to the following conclusions:

"(1) There are, from May to October, daily fluctuations of the water level in the ground, the water either rising during the night or falling less than it did during the day.

"(2) There are fluctuations extending over several days, during one portion of which the water falls at a rate faster than the average, while during the remainder of the time it either makes a positive rise or else falls at a rate below the average.

"(3) The diurnal fluctuations are very unequal in magnitude, varying in different wells from less than 0.01 or 0.02 of an inch to 1.7 inches.

"(4) The longer-interval fluctuations are not exactly synchronous, there being a lagging, with some wells, of more than twenty-four hours.

"(5) Corn is able to draw upon the permanent water in the ground, when it lies at a depth at least as great as 7½ feet, in the case of a subsoil of rather coarse sand.

"(6) Corn may reduce the per cent of water in a subsoil of sand to 7 per cent of the dry soil at a depth of 40 inches below the surface, and when the water table is but 42 inches, still lower."

"The observations [at New York State Station (*R. 1888, p. 197*)] upon the depth of the water table, as indicated by the height of water in an abandoned well near the station buildings, were commenced in December, 1886, and continued in 1887. The results are of considerable interest, as they indicate that the depth of the water table is influenced far more by season than by the amount of rainfall.

"Two facts are strikingly brought out:

"(1) Fluctuations in the precipitation from month to month did not much affect the height of the water table. The very light precipitation of January, 1887, did not stop the rise of the water table, nor did the extremely large rainfall of July of the same year cause the water table to stop falling.

"(2) The rapid rise in the water table from January 7 to April 1, 1888, was not due to large precipitation during this time, nor was the fall from May 7 to November 1 of the same year due to small precipitation."

Similar observations in 1889 were inconclusive.

Experiments at the same station (*R. 1888, p. 191*) on the progressive movement of soil water during percolation indicated "that a nearly complete displacement of the water contained in a sample of saturated soil [sand or emery flour] takes place, when a quantity of water is added at the surface equal to that already contained by the sample, and that diffusion takes place very slowly within the soil."

A series of observations (*N. Y. State R. 1887, p. 102*) with saturated soils under the receiver of an air pump in which the pressure could be varied at will and on the rate of flow from farm drains as affected by fluctuation of the barometer indicated that there was a general relation between percolation and atmospheric pressure, a reduction in pressure resulting in an increased flow.

Soils have the property, known as hygroscopicity, of absorbing moisture from the air, but the moisture derived from this source is comparatively small (*N. Y. State R. 1888, p. 196*). Ordinarily, soils give up to the air by evaporation much more moisture than they absorb from it.

The following from *N. Y. State R. 1888, p. 196*, bears on this point: "In order to ascertain if the amount of condensation [of moisture on the surface of soils on cold nights] is as great as it appears to be, two samples of soil were taken from the surface of a garden bed at 6 p. m. on April 23, and two others on the following morning. These were dried, from which it appeared that those taken at night contained on the average 7.57 per cent of water, while those taken in the morning contained 10.06 per cent. The samples were taken to the depth of about three-fourths of an inch, and the figures indicate that, to at least this depth, the soil gained in moisture content 2.49 per cent during the night. It appears, therefore, that the amount of water thus condensed is really small. If we assume that the soil increased at the same rate to the depth of 2 inches, the increase would only amount to about one-fortieth of an inch of rain."

The effect of the size of soil particles and proportion of iron on the hygroscopicity of soils has been studied at the South Carolina Station (*R. 1889, p. 13*). "In order to ascertain how much hygroscopic moisture was absorbed [by each grade of soil particles] from an atmosphere saturated with moisture, tests were made on a soil from the Spartanburg farm, which contained 11.2 per cent of ferric oxide, all of which was contained in the silt and clay." The different sized particles were exposed for a time at 70° F., and then the percentages of moisture lost by the different grades in heating at 200° C. were determined. The tabulated results indicate

that the percentages of moisture given off "increase with the lessening diameters of the grains." The author concludes from this trial and from results obtained by Prof. Hilgard that "ferric oxide clearly has a large influence in giving soils a high absorption coefficient."

Experiments bearing on this point were made at the Massachusetts Agricultural College (*Special R. 1879*). In these experiments Prof. Stockbridge showed that the air cools off more quickly than the soil at night and that dew is the result of the condensation of watery vapor arising from the soil when it comes in contact with the colder air at the surface. The process of deposition of dew is, therefore, the reverse of that generally described which supposes that the soil is the cool condensing agent. If this theory be true, practically all gain of moisture at night in the surface soil is from moisture drawn from the lower layers. This last fact has been confirmed by experiments at the Missouri Station (*College B 6, College B. 23*). From the results of repeated determinations, night and morning, of the moisture in soil, the conclusion was reached that in fair weather there is an absolute loss of moisture from soil during the night, but a gain by capillarity from below. This was substantiated by the fact that when the flow from beneath was cut off the moisture contained in the soil was actually less in the morning than at night.

The influence of temperature and water content of the air upon the absorption of moisture by soils has been studied at the California Station (*R. 1882, p. 52*). It appeared from these experiments that in a saturated atmosphere absorption increased with rise of temperature, but in a partly saturated atmosphere, steadily diminished as the temperature was raised.

The main object of tillage is to put the soil in the mechanical condition most favorable to the circulation of water, plant-food solutions, air, and gases, and to the growth of the roots of plants. We can see, then, how important is the study of the effect of tillage or cultivation upon the content and circulation of water in soils.

Surface tillage, like mulching (see *Mulching*), interferes with the capillary flow of water to the surface and saves it from evaporation.

"Computing from the observed losses (on clay loam soil) the mean daily rate of evaporation per square foot from the surfaces in the two conditions (with and without surface tillage), we get for cultivated ground 665 pounds per square foot and for uncultivated ground 808 pounds per square foot, and this is the amount of water over and above that which may have been brought into the upper 6 feet of soil from below by capillary action" (*Wis. R. 1891, p. 105*).

By destroying weeds another source of large loss of moisture is removed, for plants of all kinds draw heavily on the moisture of the soil and exhale it rapidly into the air in dry weather. "Under the conditions of good cultivation corn may draw in considerable quantities upon soil water existing at depths greater than 7 feet below the surface." (*Conn. Storrs R. 1888, p. 22; Ill. B. 3 (1887); Mich. R. 1889, p. 79; Mo. College B. 5; Wis. R. 1891, p. 100*).

As regards the effect of deeper cultivation, the results of experiments at New York State Station (*R. 1888, p. 186*) are as follows:

"(1) Keeping the surface of the soil stirred, if only to the depth of half an inch, increases the water content of the first 12 inches to a very appreciable degree.

(2) The deeper the tillage, at least up to 4 inches, the greater is the increase in water content.

(3) The rate of increase diminishes as the depth increases."

On the other hand, experiments at the Missouri Station lead to the conclusion "that the breaking up of the compact subsoil of the (station) farm increases its water-holding capacity, both in years of drought and in wet seasons." (*Mo. College B. 5, College B. 18.*)

The question of the relation between tillage and soil moisture has been quite thoroughly studied at the Wisconsin Station (*R. 1889, p. 205, R. 1890, p. 134, R. 1891,*

p. 100). A brief summary of this work in some of its more practical bearings is here attempted: In his study of soil moisture the author has found, "on several occasions, that the distribution of water in the soil changes at times quite rapidly, so that one stratum has gained in water content at the expense of a contiguous one, and this redistribution of water may be conveniently designated 'translocation.'

"The translocation of soil water is occasioned in at least two ways, namely, (1) by changing the porosity of a given stratum of soil; (2) by changing the amount of water a given stratum of soil contains." Firming the surface soil by rolling draws water up from beneath. Rains also frequently give rise to a translocation of water. This is illustrated by accounts of observations made by the author on samples of soil taken at different depths before and after a rain or artificial sprinkling, from which it appeared that there was a marked decrease in the amount of water in the subsoil when the surface soil was wet. These observations were confined to a clay soil underlaid with sand. Some of the bearings of these phenomena on the tillage of this class of soils are briefly discussed.

"(1) *Cultivation after rains.*—Unless the ground is already too wet, the stirring of the surface soil, wherever practicable, should follow just as soon after a considerable rainfall as the tools will work well. The cultivation should, as a rule, be shallow, leaving a thin stratum of the surface soil finely pulverized and completely cut off from the ground below. If this is not done the extremely rapid evaporation which takes place from undisturbed wet soil on hot, clear days may, even in a few hours, not only dissipate that which has just fallen, but also a part of that which the rain has caused to be drawn toward the surface from lower levels, and thus leave the ground actually drier, as a whole, than before the rain, even though it may look more moist at the surface.

"(2) *Watering transplanted trees.*—When dry weather follows the planting of trees it will be evident that simply wetting the surface may, in certain localities, do more harm than good, because in these cases the roots, lying as they do at considerable depths, can not use water which remains at the surface, and as surface wetting may diminish the water content of the deeper soil, the soil about the roots is liable to be rendered drier than before the wetting. * * *

"If, however, the surface soil about the trees is deeply spaded before watering, the water will then enter the ground more deeply by the direct force of gravitation, largely unimpeded by capillary action, while at the same time the ability of the soil to return the water to the surface will be reduced to the minimum, and if a good mulch is now added the water will be under the best conditions for being used by the tree. So, too, if the soil about the roots of transplanted trees is well firmed to insure the rapid transit of water to them, while the surface is left loose and well mulched at the time of setting to prevent capillary action upward above the roots and to permit the rains to penetrate downward to them, we start the tree under the best possible conditions for growth, so far as moisture is concerned."

From experiments with reference to the rate of capillary movement in fine sand and to the influence of stirring the soil on the rate of evaporation, the following suggestions were drawn (*Wis. R. 1889, p. 206*), some of which have been confirmed by more recent experiments, while others still need further confirmation.

"(1) A tool like the disk harrow, or like the curved-toothed harrows, which cuts narrow and comparatively deep grooves in the soil, leaving undisturbed ridges between them, tends to dry the ground rapidly and deeply.

"(2) Tools like the plow and some forms of cultivators, which cut the whole surface of the ground, leaving a loose layer of soil on the top, tend to dry the loosened soil, while the loss of moisture from below by capillary action and evaporation is diminished.

"(3) Deep plowing in the spring, especially if the soil is heavy, and if coarse material is turned under, would tend, unless prevented by early, heavy rains, to produce a deficiency of moisture for shallow-rooted plants, and for deep-rooted plants

during the early part of the season, by partially cutting off the water supply at a depth below the roots.

"(4) Shallow plowing or surface stirring would tend to diminish surface evaporation, and at the same time allow capillary action to lift water from below to the roots of young and shallow-rooted plants. (*R. 1891, p. 100.*)

"(5) Fall plowing and early spring treatment with tools like the disk harrow would tend to draw the water to the surface with the minerals held in solution, and thus concentrate the fertility at the surface for later use, thus preventing so much being lost by underdrainage."

Experiments in rolling soil have given the following results:

"(1) Rolling land makes the temperature of the soil at 1.5 inches below the surface from 1° to 9° F. warmer than similar unrolled ground in the same locality, and at 3 inches from 1° to 6° warmer.

"(2) Rolling land by firming the soil increases its power of drawing water to the surface from below, and this influence has been observed to extend to a depth of 3 to 4 feet.

"(3) The evaporation of moisture is more rapid from rolled than from unrolled ground, unless the surface soil is very wet, and then the reverse is true, and the drying effect of rolling has been found to extend to a depth of 4 feet."

(4) Observations on oats, clover, peas, and barley seeds indicated that "in cases of broadcast seeding, germination is more rapid and more complete on rolled than on unrolled ground." The yield of oats was increased by rolling.

A soil hygrometer with modifications is described in *N. Y. State R. 1886, p. 176, R. 1887, p. 110, R. 1888, p. 198.*

Prof. Whitney, of the Maryland Station, has given in *U. S. Weather Bureau B. 4* the methods and results of determinations of moisture in soils by means of electrical resistance.

"The method consists of burying plates of carbon or of some other good conducting material in the soil at such distances apart that the electrical resistance of the intervening soil will be about 1,000 ohms when the soil has about 8 or 10 per cent of moisture. An electric current from an induction coil is sent across from one plate to the other, and the resistance of the soil measured by a Wheatstone bridge arrangement with a telephone instead of a galvanometer. The drier the soil the higher will be the resistance. The soil appears to move away from the plates, however, and the resistance gradually increases from this cause. The movement of the soil grains seems to depend upon the barometric pressure, changing temperature, and changing moisture content of the soil."

This movement of soil particles has been made the subject of investigations, but no definite results have yet been published. (See also *S. C. R. 1889, p. 70.*)

In *U. S. Weather Bureau B. 5* Prof. King gives in details the methods and results of his investigations on soil water.

Intimately associated with the relations of soils to water is the important property which they possess of absorbing solids dissolved in the soil water. Soils vary much in respect to this property, and none possess it in unlimited extent, as is shown by the considerable amounts of mineral matter always present in drainage water.

In clay soils and those containing humus it is especially marked; in sandy soils it is much less noticeable. Soils, too, exercise a selective action in the absorption of different salts. It was found in experiments at the Indiana Station (*B. 33*) that the percentages of salts removed from the solutions tested by 100 grams of air-dry soil of the station farm was: Sodium phosphate, 29.6; sodium nitrate, none; potassium chloride, 26.5; potassium sulphate, 28; ammonium sulphate, 27.5. These results suggest that liberal dressings of phosphoric acid and potash might be safely made, but nitrogen compounds should be used only in amounts needed by crops; otherwise, there will be loss in the drainage.

RENOVATION AND RECLAMATION.—For improvement of soils by irrigation and drainage, see *Irrigation* and *Drainage*. For reclamation of alkali soils, see ***Alkali soils.***

Experiments under the direction of the Michigan Station were commenced in 1888 on the light porous soils of the jack-pine plains near Grayling, Michigan. The only manures used were marl, gypsum, and salt, the object being to enrich the soils by green manuring with the aid of cheap fertilizers. Spurry, vetch, red, white, and alsike clover, and field peas were used with good effect. Sugar beets and various grasses have been raised with good results, and the physical character of the soils has perceptibly improved (*B. 68.*)

P. F. Kefauver, of the Tennessee Station, reports (*B. vol. III, 4*) a series of experiments on land from which the soil had been washed ("galled"), leaving the subsoil exposed and scarred by deep gulleys. Success in reclaiming the land was finally attained by a liberal use of stable manure, together with mulching. (See also *Mulching.*)

Soja bean.—An annual leguminous plant resembling the bunch or upright varieties of the cowpea. The growth is erect from 3 to 4½ feet high. The stock is strong and woody. The pods occur in clusters of from two to five.

Two distinct species have been called soja beans. The small bean (*Phaseolus radiatus*) is largely used in Japanese confections, but is of no special value as a fodder plant (*Mass. Hatch B. 18*).

The large bean (*Soja hispida* or *Glycine hispida*) is the true soja or soya bean. In Japan this bean is extensively used as food for men and animals.

At the South Carolina Station (*R. 1889, p. 344*) the yield of seed was from 10 to 15 bushels per acre. At the Georgia Station (*B. 17*) soja beans yielded 1,307 pounds of beans per acre, while the yield of cowpeas on an adjacent plot was only 840 pounds. The weight of dry forage from the former was also greater than that of the hay from cowpeas.

At the Massachusetts Hatch Station (*B. 18*) the variety Medium Early White soja bean yielded at the rate of 35 bushels per acre. The variety Black Medium made a ranker growth of vine than most of the other sorts.

The soja bean is planted in drills, five to seven beans to the foot. It is cultivated like cowpeas and is utilized as a soiling crop, as hay and as silage.

For analyses see *Appendix, Tables I* and *II.*

(*Kans. B. 18, R. 1889, p. 43; La. B. 8, B. 27, 2d ser.; Md. R. 1889, p. 118; Mass. Hatch B. 7, B. 18, R. 1891, p. 9; Mass. State R. 1890, p. 171; N. C. B. 73.*)

Soldier beetles.—There are numerous species of these beetles, all of which are carnivorous and destroy many of the more serious insect pests. The best known are those preying upon the sugar-cane borer; the spined soldier bug, which kills many cotton worms; the glassy-winged soldier bug, which frequents grape vines; and the banded soldier beetle, which attacks the striped potato bug and many tree insects. If looked for, they can soon be recognized, since they are very active in their work of destruction. (*Ark. B. 15; La. B. 9, 2d ser.; Nebr. B. 14; N. C. B. 78; Tenn. B. vol. IV, 1.*)

Sorghum (*Sorghum vulgare* var. *saccharatum*, or *Andropogon sorghum* var. *saccharatus*).—For non-saccharine varieties of sorghum see *Chicken corn, Durra, Egyptian rice corn, Kaffir corn,* and *Millo maize.* Sorghum is a cane-like grass, having a general habit of growth resembling that of the taller varieties of Indian corn, but without ears. The stalk is terminated by a heavy head of small seeds. It has long been grown in numerous localities in the United States as a forage plant and for the sirup made from its sweet juice. During the past fifteen years efforts have been made to make sugar from sorghum in profitable quantities. In this work the U. S. Department of Agriculture has taken the lead, but much has also been done by experiment stations and private parties. The experiments have been in two directions—first, to improve the processes of extracting the juice and making the sugar, and secondly, to increase the sugar content in the varieties of sorghum grown for sugar making. It is impracticable here to do more than indicate the general lines in which the work has been advanced, and to point out what stations have carried on

experiments with sorghum. In the manufacture of sorghum sugar the most important improvements have been the application of the diffusion process and the introduction of the use of alcohol to separate the impurities from the juice. By these improvements the amount of sugar obtained from a ton of cane has been very largely increased. The following brief account of the process of manufacturing sugar from sorghum, as employed in the recent experiments conducted by the U. S. Department of Agriculture, is compiled from *Bulletin No. 34* of the Division of Chemistry.

The cane when brought from the fields is passed through a cutting apparatus and cut into pieces about 1 inch in length. These pieces are carried to a fanning machine, by which portions of the blades and other light particles are entirely removed. The clean pieces of cane are carried to a shredding machine, which tears them into small bits. The pulp thus prepared is carried on into the cells of the diffusion battery, where the juice is extracted. The diffusion juices are collected into clarifying tanks neutralized with lime, boiled, skimmed, and allowed to settle. The clear juice is drawn off into the evaporating apparatus, where it is concentrated to a sirup containing about 55 per cent of solid matter. This sirup is put into cylindrical tanks and mixed with an equal quantity of 90 per cent alcohol. As soon as the sirup and alcohol are thoroughly mixed the impurities in the sirup begin to settle, and in a few hours they have settled to the bottom of the tank, leaving a clear alcoholic sirup above. This clear liquor is drawn off and passed through a still, where the alcohol is entirely removed. The sirup is then ready for boiling in the vacuum pans and for concentration into sugar by the ordinary methods. The sirup made in this way can be transformed into sugar more rapidly than is possible where alcohol is not used. The sediment from the sirup is passsd through a filter press by which the alcohol sirup is removed, and a hard, firm cake is left. These press cakes may be so treated that not only the alcohol in them is recovered, but the sugar which they contain is changed into alcohol which may be used to make more sugar from other canes.

In the experiments in the improvement of varieties of sorghum the effort has been by means of seed selection and crossing, together with careful culture, to produce permanent varieties with a high sugar content. Sorghum is a plant which varies materially in its chemical composition and habits of growth under different conditions of climate and culture. Much progress has been made, but until the experiments have been carried on longer permanent success is not assured. The varieties most widely used for sugar-making have been Early Amber and Early Orange. Early Amber matures early, and under certain conditions has a fairly good sugar content, but it has a small-sized stalk, is delicate, and deteriorates easily, and after maturity rapidly loses its sugar content if left in the field. Early Orange is more sturdy and yields a large crop, but contains a large proportion of glucose, so that it is better for sirup than for sugar making. Among varieties which have given good results in recent experiments may be mentioned Collier, Colman, McLean, Folger Early, and Link Hybrid.

The following results (per acre), obtained at Medicine Lodge, Kansas, in 1891, under favorable conditions, will serve to indicate the present status of experimental tests of sorghum:

Results of experiments with sorghum in 1891.

Variety.	Whole cane.	Blades and trash.	Clean cane.	Dry seeed.	Sugar in juice.	Number of stalks.	Sugar.
	Tons.	*Tons.*	*Tons.*	*Pounds.*	*Per cent.*		*Pounds.*
Colman	12.08	1.66	8.09	....	14.50	14,022	2,071
McLean	11.69	0.97	8.61	1,768	14.55	11,147	2,104
Folger Early	13.96	1.67	10.07	2,340	15.75	....	2,745
Link Hybrid	10.72	1.26	7.67	....	13.10	11,434	1,758
Early Orange	14.54	1.64	9.86	1,937	10.20	17,533	1,767
Collier	16.36	1.88	11.48	1,304	13.75	24,339	3,021

Accounts of the experiments with sorghum conducted by the U. S. Department of Agriculture are given in the annual reports of the Department from 1878 to 1892 inclusive, and in *Bulletins Nos. 20, 26, 29, and 34* of the Division of Chemistry. The New Jersey and Louisiana Stations have done a large amount of work in connection with experiments in sugar-making and improvement of varieties (*N. J. B. 18, B. 24, B. 25, B. 30, B. 38, B. 41, B. 44, B. 51, B. 54, R. 1888, pp. 17, 133, R. 1889, p. 187; La. B. 5 (1886), B. 12 and 19 (1888), B. 21, B. 26, B. 27, B. 3, 2d ser., B. 8, 2d ser.*). The New York State and Kansas Stations have tested numerous varieties and made experiments with reference to the improvement of varieties (*N. Y. State B. 6, B. 9, B. 21. B. 78, B. 11, n. ser., B. 13, n. ser., R. 1888, p. 71, R. 1889, pp. 52, 67, 263, R. 1890, p. 162; Kans. B. 16, B. 25, R. 1888, p. 122, R. 1889, p. 90*).

Tests of varieties, analyses of the crop, and fertilizer tests are also reported in the following: *Ala. Canebrake B. 9; Ark. R. 1888, p. 68, R. 1889, p. 61, R. 1890, p. 13; Cal. R. 1878–'79, p. 91, R. 1880, p. 40, R. 1882, p. 61, R. 1888–'89, p. 139, R. 1890, p. 296; Colo. R. 1888, p. 151, R. 1890, p. 19; Del. B. 8, R. 1889, p. 29, R. 1890, p. 39; Fla. B. 12; Ga. B. 12, B. 13, B. 17; Ind. R. 1882, p. 75; Iowa B. 5, B. 7, B. 8, B. 12; Ky. R. 1888, p. 31; Md. R. 1888, p. 54, R. 1889, p. 148; Mass. State B. 34, R. 1889, pp. 169, 182, 310; Minn. R. 1888, p. 161; Miss. R. 1889, p. 19, R. 1890, p. 40; Nebr. B. 19; Nev. R. 1891, p. 16; New Mex. R. 1891, p. 8; Ore. B. 4; S. C. R. 1889, p. 342; Tenn. B. vol. III, 2; Tex. B. 13.*

Sorghum blight (*Bacillus sorghi*).—A bacterial disease, indicated by the appearance upon the leaf sheath or the leaves of small red spots and patches of various shades and sizes. They usually are brighter upon the inside of the leaf sheath than elsewhere, and begin at the top of the sheath and spread downward. The coloration becomes deeper until it is dark brown and the vitality of the underlying cells is exhausted. The roots are known to be affected in a like manner. It has been demonstrated that the bacteria live through the winter in the old stalks and stubbles. In fields which have been affected these should never be turned under, but burned. The disease is worse on some varieties of sorghum than on others, and also where sorghum is raised for several years without rotation of crops. In such places the young plants are often attacked, and either killed outright or so stunted as never to make vigorous growth (*Kans. B. 5, R. 1888, p. 281*).

Sorghum smuts (*Ustilago sorghi* and *U. reiliana*).—The first of these smuts attacks the grain and causes it to swell and finally burst, becoming entirely worthless. The other attacks the whole panicle, or head, converting it into a large black mass, covered at first by a whitish membrane. So far these fungi have attacked only the foreign varieties recently introduced into this country. As yet no preventive treatment is known to be very successful (*Kans. B. 16, B. 23*).

South Carolina rock.—See *Phosphates*.

South Carolina Station, Fort Hill.—Organized under act of Congress January, 1888, at Columbia, as a department of the University of South Carolina, removed to Fort Hill in 1890, and reorganized as a department of Clemson Agricultural College. The staff consists of the president of the college and director, vice director and agriculturist, assistant agriculturist, chemist, two assistant chemists, and assistant horticulturist. The principal lines of work are analysis and control of fertilizers and field experiments with fertilizers and field crops. Up to January 1, 1893, the station had published 4 annual reports and 15 bulletins. Revenue in 1892, $14,542.

South Dakota Station, Brookings.—Organized under act of Congress in 1888 as a department of the South Dakota Agricultural College. The staff consists of the president of the college, director and agriculturist, entomologist, chemist, irrigation engineer, dairyman, assistant entomologist, assistant horticulturist, assistant chemist, acting botanist, librarian, foreman of farm, and accountant. The principal lines of work are meteorology, field experiments with field crops and fruits, forestry, entomology, and dairying. Up to January 1, 1893, the station had published 4 annual reports and 32 bulletins. Revenue in 1892, $15,000.

Southern cattle fever [more commonly known as Texas or Splenetic fever].—A specific fever communicated by cattle from a certain infected district in the South, or contracted by cattle imported into that region. The cattle which transmit the infection are apparently healthy, while diseased animals do not, as a rule, infect others.

The seacoast region from Virginia to Mexico contains the germs of the disease, and the infected region extends some distance from the sea, embracing parts of Virginia and North Carolina, most of South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana, the southern part of Tennessee, and a large portion of Arkansas, Indian Territory, and Texas.

The fever is caused by an organism which exists in the red corpuscles of the blood and breaks them up, thus making it necessary for the system to get rid of a large amount of solid waste material. The overworked liver and kidneys become diseased. The temperature rises to 106° or 107° F., the animal becomes dull, loses its appetite, and lies down alone. The bowels are constipated. At a late stage of the disease the urine becomes deeply stained with the red coloring matter of the blood. This coloring is generally considered a fatal symptom. The animal becomes emaciated and the blood very thin and watery. The disease is usually fatal in from three days to several weeks, though sometimes there is a slow recovery.

Medical treatment has generally been unsuccessful. Epsom salts have perhaps been most extensively given. Sulphate of quinia, in doses of 15 to 30 grains, and tincture of aconite root have been used.

Cold weather prevents the spread of Southern cattle plague, while a certain degree of warmth is favorable to it. Thirty to fifty days may elapse after the contamination of a pasture by Southern cattle before the disease appears. But if cattle are placed on pasture in which the germs have existed for some time they may become diseased in thirteen to fifteen days.

The Bureau of Animal Industry, while admitting the possibility of other sources of infection, states that it is carried North by the ticks from Southern cattle. When Northern cattle are carried South it is recommended that the winter months be chosen for shipment, that the animals be kept free from ticks, and separated from native cattle during the first year. Young animals carried South are less apt to die than grown cattle.

By means of regulations governing the movement of cattle from the infected region, now made yearly by the Secretary of Agriculture, the disease has been very largely prevented.

Accounts of observations and experiments on this disease at the stations are given in *Ark. R. 1888, p. 91, R. 1889, p. 119, R. 1890, p. 99; Mo. College B. 24, College B. 31, B. 11; Nebr. B. 3, B. 7, B. 8, B. 9, B. 10; Tex. College B. 4, B. 5, R. 1888, p. 12, R. 1889, p. 55.*

Spaying.—The removal of the ovaries, the essential organs of generation of female animals. This operation is successfully performed on cows, sows, and other domestic animals. It has been practiced quite extensively, especially in European countries, with a view to perpetuating the flow of milk of cows without the interruption of dry spells and calving. "Cows that are spayed at the age in which they give the largest yield of milk—after the third calf—provided they are fed and tended properly, continue to milk in almost undiminished quantity, except as influenced by the food, for a very considerable period after being operated on. The length of time is somewhat uncertain, but is usually stated to be two or three years." Observations at the Arkansas Station (*B. 8, B. 12*) showed that four months after spaying there was no falling off in yield of milk and no particular change in quality. There was a temporary shrinkage in milk, lasting for two or three days after the operation.

Spelt.—A kind of wheat generally known as *Triticum spelta*, but probably a race of the common wheat. The grain is adherent to the chaff. Spelt is a mountain

grain. It was found to be poorly adapted to the warm San Joaquin region in California. (*Cal. R. 1890, p. 290.*)

Spinach (*Spinacia* spp., etc.).—The varieties of this vegetable (*S. glabra* and *S. oleracea*) have been investigated chiefly at the New York State Station (*R. 1883, p. 208, R. 1884, p. 283, R. 1885, p. 188, R. 1887, p 325*). In the *N. Y. State R. 1887, p. 225,* are found full descriptions of 10 varieties, including one prickly seeded variety.

Experiments with earliest and latest ripened seed from the same plant and seed from the earliest and latest matured plants are noted in *N. Y. State R. 1884, p. 284.* The earliest ripened seed on the plant vegetated considerably better than the latest. The plants grown from the latest ripened seed bloomed two days later. Seed from the earliest ripened plant vegetated slightly better and bloomed about three days earlier than seed from the latest ripened plant. Using the earliest seed on a plant, while it had been found to give a larger vegetation, appeared to shorten the period of usefulness of the plant.

The root system of spinach was observed at the same station (*R. 1884, p. 308*). The deepest growing roots extended about 2 feet downward, and the horizontal roots seemed chiefly to lie at a depth of about 6 inches, though many fibrous roots rose to within 2 inches of the surface.

Germination tests of spinach seed are reported in *N. Y. State R. 1883, pp. 61, 70; Ore. B. 2; Vt. R. 1889, p. 108.*

The "New Zealand spinach," a plant of a different genus (*Tetragonia expansa*), was planted with the common species at the New York State Station in 1883 and 1887. It is described (*R. 1883, p. 208*) as a low annual plant with spreading, branching stems, numerous thick, fleshy leaves, and greenish inconspicuous axillary flowers, of which the leaves are used like those of common spinach, but develop later. It was found to remain in edible condition all summer and up to October.

For French spinach see *Orach.*

Spinach, leaf blight (*Phyllosticta chenopodii*).—This fungus appears upon the leaves, usually on the lower half, in the shape of minute pimples. These increase in number until quite an area is covered. When the spores are mature they escape in a stream from the top of the pimple. Upon drying they are blown to other leaves and thus the disease is spread. Another disease, the black mold, caused by the fungus known as *Cladosporium macrocarpum,* is abundant upon older leaves and often upon the stock in market, giving it an unattractive appearance and causing it to quickly rot. Equal parts of air-slaked lime and sulphur well raked into the soil will be effective in preventing this and other diseases of spinach. (*N. J. B. 70.*)

Spinach, mildew (*Peronospora effusa*).—This fungus, which is related to quite a number of other very destructive ones, often causes heavy losses to the grower. It forms grayish-colored patches upon the under side of the leaves, while on the upper side, opposite them, the green tissue will become yellowish, due to the attack of the fungus upon the underlying cells. Wherever it sends its filaments they sap the cells, causing the final destruction of the leaf. It is said to grow on other plants, such as the pig-weed or lamb's quarters, and these should be rigidly kept away from spinach beds. For other preventive measures see *Spinach, leaf blight.* (*Mass. State R. 1890, p. 221; N. J. B. 70.*)

Spinach, white smut (*Entyloma ellisii*).—A fungous disease, giving the leaf the appearance of being covered with a fine frost. The attacked leaves lose their normal color and become a sickly yellowish green. It forms two kinds of spores, one within the leaves, the other on their surface. This disease is of recent discovery and but little is known of it. The precautions given for leaf blight should be followed and will probably aid in keeping it from spreading. It has not been very destructive so far. (*N. J. B. 70.*)

Splenetic fever.—See *Southern cattle fever.*

Spraying apparatus.—See *Fungicides* and *Insecticides.*

Spruce trees (*Picea* spp.).—The forests of black spruce (*P. nigra*) in West Virginia are described in *W. Va. R. 1890, pp. 98, 171*, from observations made in a trip to investigate the extensive destruction of the trees (as it proved) by the attacks of a beetle. Statistics respecting the extent and distribution of the forests and the quality of the wood are introduced. The area is estimated as over 500,000 acres, of which perhaps 150,000 acres are dead. The beetles work in the bark and the sap-wood. The dead trees are available for timber, into which, it is judged, they may be profitably worked for a period of eight years after death. The station is now making experiments with a parasitic insect introduced from Europe, which, it is hoped, will greatly diminish the ravages of the beetle which destroys the spruce forests.

Various spruces planted at the South Dakota Station and elsewhere in the State are noted in *B. 12, B. 15, B. 20, B. 23, B. 29, R. 1888, p. 26.* According to *B. 23* the white spruce (*P. alba*), which is one of the principal forest trees of the Black Hills, can be grown in any part of the State; Norway spruce (*P. excelsa*) may be successfully cultivated in the southern counties, while Colorado blue spruce (*P. pungens*) is as hardy as white spruce, but is a high-priced tree.

Several species are somewhat fully noted in *Minn. B. 24* with reference to the conditions of that State. The white spruce (*P. alba*) is regarded as perhaps the best spruce for the State, being much hardier than the Norway spruce, and though less graceful in habit, still a beautiful tree. The Norway spruce, however, is generally doing well in the State and is estimated as very desirable not only for ornament but also for wind-breaks. It is far more easily obtained than the white spruce. The black spruce, though much more common in the native forests of the State, is comparatively worthless for planting, a slow grower with a decidedly dirty aspect on account of the persistence of the cones, and further unsightly on account of its enfeebled growth, which begins to show when the trees first bear seed. This tree is sold by unscrupulous persons for the white spruce, the two being similar when young.

The Colorado blue spruce is stated to be a tree of exceeding great beauty from the Rocky Mountains, where it is found growing in very severe exposures. Its chief beauty lies in the light blue color of the foliage, found, however, only in about one-third of the seedlings, while the remainder are of a rich green. Though there were no large specimens in the State it was believed that it would prove a decided acquisition.

Engleman's spruce (*P. englemanii*), a somewhat similar tree from the Rocky Mountains, is noted as very pretty and desirable, but not yet thoroughly tested.

For Kansas (*B. 10*) the Norway spruce is considered as holding a second rank only, on account of its uncertain resistance to unfavorable climatic conditions. In resistance to drought it appears inferior both to the white spruce and the Colorado blue spruce. The white spruce is judged to be "one of the best of the more ornamental evergreens for planting in middle and eastern Kansas." The Colorado blue spruce is "in hardiness fully the equal, and in distinct beauty the superior, of the white spruce." Brief recommendations of the two latter occur in *Iowa B. 16.*

For Douglas's spruce see *Fir.*

Spurry (*Spergula arvensis*).—An annual forage plant which prefers sandy soil. On the jack-pine plains of Michigan, spurry has proven valuable. It produces a large amount of forage and its introduction has been a benefit to this region. (*Mich. B. 68.*)

At the Maine Station (*R. 1889, p. 168*) it bloomed two months after sowing and made a growth 15 inches high. It produces a great quantity of seed and is difficult to get rid of.

At the Oregon Station (*B. 4*) the yield was 20 tons of green forage per acre. At the Louisiana Station (*B. 27*) the growth was but 10 to 12 inches. The Pennsylvania Station (*R. 1887, p. 141*) secured 3,403 pounds of dry hay per acre from spurry. It is readily eaten by cattle.

Squash (*Cucurbita* spp.).—Variety tests of the squash are recorded in *Ala. College B. 2; Ark. R. 1889, p. 104; Colo. R. 1889, pp. 42, 102, 122, R. 1890, pp. 194, 210; La. B. 3, 2d ser.; Md. 1889, p. 62; Mich. B. 70, B. 79; Minn. R. 1888, pp. 253, 261; N. Y. State R. 1882, p. 128, R. 1883, p. 185, R. 1884, p. 205, R. 1885, p. 124, R. 1886, p. 240, R. 1887, p. 323; Pa. B. 14; Utah B. 3.*

N. Y. State R. 1887, p. 243, contains a joint classification of squashes and pumpkins, covering 55 varieties, of which 40 are classed as squashes, being referred in part each to *C. Pepo, C. maxima,* and *C. moschata.* Full descriptions are given with English and foreign synonyms and an index of all the names. In *Mich. B. 48* an illustrated account is given of experiments in cross-fertilizing squashes which led to the conclusion that only the seeds were affected the first year. Experiments on pumpkins and squashes at the New York Cornell Station (*B. 25*) gave the same result; they also indicated that *C. Pepo* and *C. maxima* do not hybridize, and that in pumpkins and squashes pollen is impotent on pistils of the same plant. In experiments in herbaceous grafting (*ibid.*) pumpkin vines were found to unite with squash.

Germination tests with squash seeds are reported in *N. Y. State R. 1883, p. 70; Ohio R. 1885, p. 176, R. 1886, p. 254; Ore. B. 2; Vt. R. 1889, p. 109.*

Squash bug (*Anasa tristis*).—The adult insect is a beetle about half an inch long, brownish black above and dull yellowish beneath. The females lay their eggs on the under side of leaves, gluing them together. The eggs hatch in a few days into young beetles greatly resembling the adult. The perfect insect spends the winter under rubbish and comes out early in the spring. They are so persistent and numerous that the vines soon wilt under their attack.

Hand picking and destroying the eggs are the most satisfactory means of treatment. Kerosene emulsion will kill the young bugs. A small dark gray fly is known to be parasitic on this bug, destroying many of them. (*Colo. B. 6; Mass. Hatch B. 12; Mich. R. 1889, p. 95; N. Mex. B. 2; S. C. R. 1888, p. 26.*)

Steers.—See *Cattle.*

Strawberry (*Fragaria* sp.).—The strawberry has been more widely and constantly grown at the stations than any other small fruit. The study of this fruit has consisted most largely in the comparison of its numerous varieties, but various culture questions have also been touched, and the enemies of the plant often investigated.

Botanical notes on the occurrence of plants with five leaflets instead of three and of white-fruited and double-flowered forms are made in *N. Y. State R. 1887, p. 43.*

VARIETIES.—Tests of varieties are recorded: *Ala. College B. 2, B. 1, n. ser., B. 20, n. ser., B. 29, n. ser.; Ala. Canebrake B. 12; Ark. B. 7 (R. 1888, pp. 50, 54), B. 11 (R. 1889, p. 82), B. 13 (R. 1890, p. 433), B. 17; Cal. R. 1888-'89, pp. 88, 110; Colo. B. 17, R. 1889, pp. 29, 111, R. 1890, p. 31; Del. B. 18; R. 1889, p. 103, R. 1890, p. 92, Fla. B. 14; Ga. B. 11; Ill. B. 21; Ind. B. 5, B. 10, B. 31, B. 33, B. 38; Kans. B. 26; Ky. B. 25, B. 32; La. B. 26 (R. 1889, p. 430), B. 3, 2d ser.; Md. B. 9, R. 1890, p. 104, R. 1891, p. 412; Mass. Hatch B. 6, B. 10, B. 15; Mich. B. 55, B. 59, B. 67, B. 80, B. 81; Minn. B. 18, R. 1888, p. 231, Miss. R. 1891, p. 29; Mo. College B. 20, B. 26, Mo. B. 10, B. 13, B. 16, B. 18; Nev. R. 1890, p. 30; N. Y. State B. 24, n. ser. B. 36, n. ser., B. 44, n. ser., R. 1883, p. 226, R. 1885, p. 224, R. 1886, p. 253, R. 1887, p. 333, R. 1888, p. 95, 229, R. 1889, p. 298, R. 1890, p. 259, R. 1891, p. 460; N. C. B. 72, B. 74; N. Dak. B. 2; Ohio R. 1884, pp. 108, 121, R. 1885, p. 99, R. 1886, p. 180, R. 1887, p. 245, R. 1888, p. 103, B. vol. II, 4 (R. 1889, p. 101), B. vol. III, 7 (R. 1890, p. 211), B. vol. IV, 6 (R. 1891, p. 115); Ore. B. 7, B. 12; Pa. B. 8 (R. 1889, p. 163), B. 18; R. I. B. 7; S. Dak. B. 23, B. 26; Tenn. B. vol. II, 4, R. 1888, p. 12; Tex. B. 8 (R. 1889, p. 30), B. 16; Utah B. 10; Vt. R. 1888, p. 120, R. 1889, p. 123, R. 1890, p. 184; Va. B. 7; Wis. 1890, pp. 213, 274, R. 1891, p. 142.*

The varieties grown run up to 150, and not seldom the data given are very full—*e. g.*, in *Ark. B. 13; Ind. B. 33, 38; Kans. B. 26; Md. B. 9; Mich. B. 80, B. 81; N. Y. State R. 1890; Ohio R. 1888, R. 1889, R. 1890; Tenn. B. vol. II, 4, Tex. B. 8.*

The essentials of a good variety are stated in *Ohio B. vol. III, 7* (*R. 1890, p. 210*), and some generalizations are presented upon the relation of length of season and fruitfulness among varieties, and the length of season of early and late as compared with medium varieties.

To compare the productiveness of perfect and imperfect flowered varieties, a list of eight of each class was sent to growers for their marking. According to the data obtained, the imperfect flowered plants were considerably more prolific than the perfect flowered.

Experiments were carried on at the Ohio Station (*R. 1884, p. 119, R. 1885, p. 107, R. 1887, p. 253*) for three seasons with strawberries to learn the influences of cross-fertilization upon the fruit of the first year. The first season modifications of the fruit in form, size, color, and general appearance seemed to result; the second season there was some apparent effect, but the results seemed far from decisive; those of the third year were not regarded as warranting positive statement. In crossing experiments at the New York State Station (*R. 1890, p. 274*) many of the pollenized flowers gave fruit utterly unlike either parent. Some of the results are illustrated by cuts. In the same report experience in growing seedlings is noted. Of 1,000 seedlings, but 20 were saved as showing any indications of value, and of these 15 were discarded the next season. In *Ohio R. 1887, p. 253,* the question is briefly touched whether pistillate varieties will fruit when standing alone. While this seemed sometimes to occur, it was judged not safe to depend upon it.

The influence of rain on pollination has been somewhat investigated by the New Jersey Station (*B. C, R. 1890, p. 330*). Plants kept continually wet by sprinkling during the flowering season gave a smaller crop, and the berries were very irregular. This result is referred to the exclusion of bees by the moisture. Where plants were kept dry by a canvas the berries were the same as elsewhere in the field, the advantage of dryness being perhaps offset by the fewer visits of bees under the canvas. There were fewer young berries under the canvas, and the indications were that its use is unprofitable.

COMPOSITION.—See *Appendix, Table III.* Analyses of strawberries are recorded in *Mass. State R. 1888, p. 233, R. 1889, p. 306, R. 1890, p. 305; Ohio R. 1887, p. 259, R. 1888, pp. 108, 110; Tenn. B. vol. II, 4.*

At the last-named station 17 varieties were examined, and the determinations were of water and dry matter, sugar and acid, and food constituents.

The food and dietetic value of the strawberry is discussed with some fullness in *Ohio R. 1887, p. 259.* In the same place and in the Tennessee bulletin the increase of sugar relatively to acid in the cultivated varieties as compared with the wild plant is noted; also, in the Ohio reports, the relative diminution of the seed in the cultivated plant.

CULTURE.—A new method of propagation is described in *Ohio R. 1886, p. 187,* consisting "simply in removing the young runners from the plant as soon as, or even before, they have taken root, and propagating in a cold frame; or, in other words, treating the young plants as florists treat cuttings." The essential conditions are plentiful moisture and partial shade. By this method "well-rooted plants can be grown nearly a month earlier than in the field." Experiments at the same station (*R. 1888, p. 104*) indicated that market gardeners might profitably grow strawberries as a second crop by close planting, though the yield was less than when the plants had a whole season. But planting after August 1 in that latitude did not seem desirable in any case.

A successful method of setting strawberries is described in detail in *Tex. B. 16* and instructions for planting are given with cuts in *Ark. R. 1889, p. 82.*

An experiment at the Michigan South Haven Station (*B. 80*) showed in the great majority of cases a larger—often much larger—yield of fruit from the same variety under the hill system than from the matted row, "and the increase is not from a greater number of fruits so much as from their greater size and beauty." Notes

favorable to hill cultivation are also found in *Mass. Hatch B. 10.* In *Ga. B. 15* the two methods are compared to the advantage of the hills; also a third method is highly recommended, viz, setting the plants 15 inches apart in the row and placing the rows 3 feet apart, permitting a matted row 1 foot wide to be formed. This system admits of cultivation by horse power.

The effect of mulching has been a subject of some study. At the Ohio Station (*R. 1884, p. 120, R. 1885, p. 106, R. 1887, p. 252*) observations were made on the temperatures of straw-covered and bare ground, mostly in the month of May, for three seasons, showing that the temperature falls lower over the straw sufficiently to make the danger of frost slightly greater; but it was believed that the risk was more than offset by the protection afforded against drought and winter-killing, the value of which was also shown by experiment. Where the ground was weedy it seemed advisable to remove the straw and after cultivation to replace it, though this increased the danger from drought. At the Alabama College Station (*B. 1, n. ser., B. 4, n. ser.*) mulching was found to insure relatively the growth of young plants, to retard ripening, and to increase the yield. It was asserted, however, that in that climate the crowns should not be covered, and was suggested that on account of the delay of ripening one-half of the bed should be left unmulched. In *Va. B. 7* mulching is earnestly advocated. The straw was there removed in April, and after cultivation spread again between the rows and scattered lightly over them in order that the plants might grow through and the fruit be kept clean. At the Texas Station (*B. 8*) mulching was deemed not profitable in the South. At the Alabama College Station (*B. 1, n. ser.*) the experiment was tried of removing the fruit stalks from plants the first season with results showing the practice to be unprofitable.

At the New York Station (*R. 1884, p. 325*) an experiment in irrigating strawberries was made, which showed that an excess of water injured the quantity and quality of the crop, but that a moderate supply in dry weather was an advantage.

General notes on culture are given in *Ala. B. 4, n. ser.; Ga. B. 15; N. Dak. B. 2; Tex. B. 8.*

MANURING.—Experiments with fertilizers on strawberries are recorded in *Del. B. 11; N. J. R. 1891, p. 141; Ohio R. 1888, p. 108.* The New Jersey experiment showed a gain of 31 per cent in yield from the use of nitrate of soda. Notes on manuring strawberries occur in *Ga. B. 15.*

Strawberry, crown borer (*Tyloderma fragariæ*).—The larva of this insect is a small white footless grub one-fifth inch long, with a light yellow head. The adult is a brown beetle one-sixth inch long, resembling the plum curculio. The eggs are laid in the crown of the plant. The young grub burrows about in it and emerges in the fall to spend the winter in the ground. They do not spread rapidly owing to their inability to fly. Old plants are most affected and should be completely destroyed after the bearing season is over. Burning over the patch during the summer will destroy them.

Do not plant strawberries continuously on the same ground. Insecticides are of little value. (*Ind. B. 33; Ky. B. 31; N. Y. State B. 35, n. ser.; Ore. B. 5.*)

Strawberry, leaf blight (*Sphærella fragariæ*).—A fungous disease which, as a rule, does not appear to cause much injury until after the plants are through bearing. It is carried over the winter in the tissues of the old leaves. The disease is characterized by the appearance of reddish spots on the upper surface of the leaf. The center becomes grayish white and the border more or less purple. In these spots are developed the spores which propagate the fungus. Its spread may, in a great degree, be controlled by removing and burning all old leaves. Frequent resetting of the beds is also recommended, so that the plants may be young and vigorous. Some varieties are more liable to attacks than others. After removing the old leaves the young ones may be sprayed with Bordeaux mixture or eau celeste with great advantage. They should have three or four applications. The use of ammoniacal copper carbonate is also recommended by some persons. The old leaves may be

removed by hand or cut off and raked up, but they should always be burned. (*Conn. State B. 111; Ky. B. 31; N. Y. Cornell B. 14; Vt. R. 1890, p. 142.*)

Strawberry tree (*Arbutus unedo*).—This tree, "the true madroño of Spain," is noted in *Cal. R. 1889, pp. 110, 138.* "It is a true ornament to any garden, while its sweet berry, very much resembling in appearance and taste the strawberry, might make it profitable fruit. In Spain the berries are much liked, and are canned, and in this condition find their way even to Spanish-America. The tree is an evergreen with dark shining green leaves. The flowers, produced in great abundance at the ends of the branches, are of the well-known urn shape, and, like those of our madroño and madzanita, of a transparent white." The berries do not mature till the second season, when their beautiful crimson, mingled with the transparent white of the flowers, makes the tree highly ornamental. (*Cal. R. 1890, p. 236*).

Subsoiling.—The experiments undertaken to determine the effects of subsoiling have given conflicting testimony, due largely to differences in climatic conditions and the character of the soils. During four seasons (1871–'74) the Wisconsin Agricultural College secured in dry seasons larger yields of corn on subsoiled plats, but in wet seasons the results were reversed. (*Trans. Wis. State Agr. Soc., 1872–'73, p. 464, 1873–'74, p. 53.*)

The average of results in subsoiling corn at the Pennsylvania Agricultural College in 1869 and 1870 was in favor of subsoiling. (*Pa. Agr. Soc., vol. VII, p. 472.*)

At the Kansas Station the average yield of corn during two years (1882–'83) was practically the same whether the land was subsoiled or not. (*Kans. R. Bd. of Agr., May, 1884, p. 6.*)

At the New York State Station (*R. 1889, p. 295*) there was a decided loss of total green matter from subsoiling corn intended for silage. During the same season and at the same station subsoiling increased the total yield of oat straw and grain, but an attack of rust vitiated the experiment. The season was one of heavy rainfall.

A test of subsoiling for oats made at Cornell University in 1875 was apparently in favor of not subsoiling. (*Cornell Univ. Studies in Practical Agriculture, 1887, p. 82.*)

For two years the South Carolina Station (*R. 1889, p. 256*) conducted subsoiling tests with corn at three farms in different parts of the State. The average for two years and for all the farms shows no appreciable effect from subsoiling on light sandy soils.

At the Missouri College (*B. 5, B. 18*) subsoiling increased the per cent of water present in the soil. With corn this naturally gave the best results for subsoiling in seasons of protracted drought, while the subsoiled plats yielded less in cold wet seasons.

Sugar beet.—See also *Beet.* By special selection and culture varieties have been developed from the common garden beet which contain a large percentage of sugar Immense quantities of sugar are manufactured from beets in Europe, especially in Germany and France. In recent years efforts have been made to introduce this industry into the United States. Much information regarding the culture of sugar beets and the making of beet sugar has been published by the U. S. Department of Agriculture and by a number of the stations. Experiments in growing sugar beets have been made in many States, and factories for beet sugar are in operation in California, Nebraska, and Utah. A popular summary of information on the culture of the sugar beet was recently published as *Farmers' Bulletin No. 3* of the U. S. Department of Agriculture, from which the following brief statements have been compiled.

Experience has shown that the sugar beet reaches its highest development in regions having a mean summer temperature of about 70° F. In the United States the region includes portions of Connecticut, Massachusetts, Vermont, New York, New Jersey, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, South Dakota, Nebraska, Colorado, New Mexico, Arizona, Utah, Idaho, Nevada, Washington, Oregon, and California. As a rule a rainfall of from two to

four inches during the summer months is required for sugar beets, but moisture may be supplied from the soil, as in certain localities in California and Nebraska, or by irrigation. A sandy loam is considered the best soil, but good beets can be produced on any soil suitable for corn, wheat, or potatoes. The land should be reasonably level and good drainage (with tiles if necessary) is essential. Among the varieties most widely grown in Europe are Vilmorin Improved, Klein Wanzleben, White Excelsior, White Imperial, Simon Le Grande, Florimond and Bulteau Desprez Richest, and Brabant. The first two have been most extensively used in this country. The quality of the seed is of the highest importance. This can be maintained only by the most painstaking care. In Europe the production of the seed is a distinct branch of the beet-sugar industry. At the time of harvest the best average beets for sugar, weighing 20 to 24 ounces, regular in form, and smooth, are carefully harvested and the leaves cut off without injuring the neck of the beet. These beets, known as "mothers," are carefully protected against frost, in piles covered with earth (or straw). In early spring the "mothers" are tested to determine the density of their juice and their sugar-content. This test is made on a small piece of the beet removed with an appropriate instrument from the center of the root. The standard of excellence for beet mothers is 16 to 18 per cent of sugar, with a purity of 85. The "mothers" are used only for the production of seed.

CULTURE.—The land intended for sugar beets should be plowed in the autumn to a depth of at least 9 inches and subsoiled 6 or 7 inches deeper. In the spring the surface of the soil should be reduced to perfect tilth by thorough cultivation immediately before planting. Planting may be by hand or by drill. If the drill is used 15 to 26 pounds of seed per acre are required, if the planting is by hand, only 10 to 15 pounds. If the soil is moist the seed should be covered only one-half inch, if dry one and one-half inches. As soon as the beets are large enough to mark the rows cultivation with the horse or hand hoe may be commenced. When the plants have four leaves they should be thinned to eight or ten inches apart, leaving the most vigorous plants. At the same time a thorough hoeing by hand should be made. About once a week during the season of growth (6 to 8 weeks) the crop should be cultivated with narrow cultivators to remove weeds and keep the soil in proper tilth. Care should be taken not to injure the leaves or root of the beet.

MANURING.—The soil ingredients most essential for the sugar beet are nitrogen, phosphoric acid, potash, lime, and magnesia. The last two can ordinarily be supplied by the press cakes from the sugar factory. If, however, lime is needed land plaster, burned lime, or ground shells may be used. Potash may be supplied in the form of the molasses and other residues from the sugar factory, and of the ordinary commercial salts. Ground bone, superphosphate, or basic slag will supply the phosphoric acid; and dried blood, tankage, cotton-seed meal, or nitrate of soda, the nitrogen. Stable manure should be applied to the previous crop and not to the beets themselves. If nitrogenous fertilizers are applied too freely the value of the beet for sugar making will be reduced. Beets should follow wheat or other cereal. A good rotation is wheat, beets, clover, potatoes.

HARVESTING.—The time varies, but in general beets planted the first week in May may be harvested about October 20. Harvesting may be delayed if there is no danger of a second growth. The beets should first be loosened in the soil and then removed by hand. For loosening the beets a specially devised machine may be used. The tops are next removed by cutting the necks of the beets with a large knife. The topped beets are thrown into piles and covered with the tops until they can be delivered at the factory.

MANUFACTURE OF SUGAR.—This is carried on in large factories by the diffusion process.

"The beets are first conveyed to washing-tanks provided with suitable apparatus for keeping them in motion and transferring them toward the end from which the

fresh water enters, in order that the whole of the adhering soil, together with any sand and pebbles, may be completely removed. By a suitable elevator the beets are next taken to a point above the center of the battery, whence they are dropped into a slicing apparatus, by which they are sliced into pieces of greater or less length and of small thickness, so that when placed in the cells of the battery they will not lie so closely together as to prevent the circulation of the diffusion juices. The slices, commonly called cossettes, next pass into the diffusion battery, in which the sugar is extracted in the usual way. The extracted cossettes are carried through a press, by which a portion of the water is removed, and they are then in suitable condition for use as cattle food. The diffusion juices are carried to carbonatation or saturation tanks, where they are treated with from 2 to 3 per cent of their weight of lime and afterward with carbonic acid until nearly all of the lime is precipitated. The slightly alkaline juices are next passed through filter presses, by which the precipitated lime and other matter are removed. The juices pass next to a second set of carbonatation tanks, in which they undergo a treatment in each particular similar to the one just mentioned, except that the quantity of lime added to the second saturation is very small as compared with that of the first. The refiltered juices from the second saturation are carried to the multiple-effect vacuum-pan and reduced to the condition of sirup. The sirups are taken into the vacuum strike pan and reduced to sugar called masse cuite, containing from 6 to 10 per cent of water. The uncrystallized sirups together with the water are separated from the sugar by the centrifugals, and form the molasses. The molasses is either reboiled and a second crop of crystals obtained, or is treated in various ways for separating the sugar which it still contains. One of these methods which has come into general use is known as the Steffen process. Another method consists in separating the salts which prevent the crystallization of the sugar by the process of osmosis. A third method consists in the use of strontium salts for the separation instead of lime salts, as in the Steffen process; or, finally, the molasses may be subjected to fermentation and distillation and the sugar therein contained thus converted into alcohol.

"The above is the general method used for the manufacture of raw sugar. If refined sugar is to be made the juices and sirups are passed over bone black to decolorize them and the crystals are washed in the centrifugal in order to make them perfectly white. Another method consists in treating the juice with sulphurous acid and purifying the crystals by washing them with sirups of varying degrees of consistency until all the molasses adhering thereto is washed away." (*U. S. D. A. Farmers' B. 3.*)

The results of experiments by the Department, the stations, and farmers show that sugar beets with satisfactory sugar content may be grown at least in portions of California, Colorado, Michigan, Minnesota, Nebraska, Nevada, South Dakota, Utah, Wisconsin, and Wyoming. It remains to be determined whether the economic conditions will warrant the establishment of factories. If the industry is to be successful not only ample capital for the equipment of factories must be secured, but the manufacturer must have assurances that the farmers in his locality will perform the painstaking labor necessary to produce good beets and will see to it that the quality of the beets is kept up by the use of good seed.

Detailed information regarding the history and culture of sugar beets and the process of making beet sugar may be found in the following publications of the U. S. Department of Agriculture: *Special R. 28 (1880); Division of Chemistry B. 5, B. 27, B. 30, B. 33.* (The last two give accounts of experiments in 1890 and 1891.)

The work of the stations on sugar beets has been in testing varieties, analyzing samples of beets grown at the stations and by farmers, and publishing information regarding the methods of culture with special reference to the needs of their several localities. The earliest work was by the California Station in 1876 and the Connecticut State and North Carolina Stations in 1878.

The following list includes most of the publications on sugar beets issued by the

stations: *Ark. R. 1890, p. 11; Cal. R. 1876–'77, p. 56, R. 1878–'79, p. 53, R. 1880, p. 38, R. 1890, pp. 115, 296; Colo. B. 7, B. 11, B. 14, R. 1888, p. 149, R. 1890, p. 191; Conn. State R. 1878, p. 124; Ind. B. 18, B. 31, B. 34, B. 39; Iowa B. 8, B. 12, B. 15, B. 17; Kans. B. 16, B. 31; Ky. B. 5; Md. R. 1890, p. 133; Mass. State R. 1888, p. 139, R. 1889, p. 170, R. 1890, pp. 179, 306; Mich. B. 46, B. 68, B. 71, B. 82, R. 1889, p. 84; Minn. B. 2, B. 14, B. 21, R. 1888, pp. 102, 395; Mo. B. 17; Nebr. B. 13, B. 16, B. 21; Nev. B. 12, B. 13, R. 1891, p. 22; N. Y. Cornell B. 25; N. C. B. (1878), R. 1879, p. 90; N. Dak B. 5; Ohio B. vol. V, 2; Ore. B. 4, B. 17; S. Dak. B. 14, B. 16, B. 19, B. 27, R. 1890, p. 10; Utah R. 1891, p. 43; Wash. B. 3; Wis. B. 26, B. 30, R. 1891, p. 176; Wyo. B. 3.*

Sugar cane (*Saccharum officinarum*).—A perennial plant of the grass family. It grows 6 to 14 feet high, has broad leaves shaped somewhat like those of Indian corn, and does not produce seed in the United States. It is propagated by planting the entire cane. After the first year the growth springs from the stubble of the preceding year. Sugar cane has been cultivated in Asia from remote ages, and is now extensively grown in tropical countries in both hemispheres. In the United States it is not cultivated on a large scale north of Louisiana. Louisiana is the great sugar State of the Union and maintains an experiment station for the study of questions relating to the growth of sugar cane and the manufacture of sugar. This station was first located at Kenner and is now at Audubon Park, New Orleans. Unless otherwise noted, statements in this article are based on the work of the Louisiana Sugar Station.

VARIETIES.—Two varieties of sugar cane are popular in Louisiana, the purple and the striped or red ribbon cane. At the sugar station the striped cane has given the heavier yield and the higher per cent of sugar. The striped cane has more foliage and grows larger, but produces less stalks to the acre than the purple. The latter is believed to be more hardy and to stand a greater degree of cold, and has less tendency to variation of type than the striped cane. A number of foreign varieties were found to be identical with the valuable variety La Price. Other promising foreign varieties are Mexican Striped, Batavian Striped, Pupuha, and Kokea. Some foreign varieties are yearly improving as they become better acclimated. When foreign varieties were grown at the stations at Baton Rouge and Calhoun the growth was much diminished, but in many instances the sugar content was increased. A foreign cane called Japanese or Zwinga withstands considerable cold and hence is promising for latitudes just north of the sugar-cane belt. It is a hard white cane of good length, small diameter, and relatively low sugar content.

COMPOSITION.—Naturally the composition of sugar cane varies greatly with different seasons and localities. The following table gives results of some analyses made at the Louisiana Station and at the same time affords data as to total yield of cane planted at different distances.

Experiments in different widths of rows in stubble cane for 1891.

	Fiber.	Average weight of stalks.	Number of stalks per acre.	Yield per acre.	Analysis of juice.			
					Total solids.	Sucrose.	Glucose.	Purity coefficient.
	Per cent.	*Pounds.*		*Tons.*	*Per cent.*	*Per cent.*	*Per cent.*	
3 rows 3 feet wide	9.70	2.38	34,813	41.45	14.53	10.91	1.61	75.09
3 rows 4 feet wide	9.55	2.42	27,720	33.21	14.09	10.50	1.60	74.52
3 rows 5 feet wide	10.84	2.46	30,520	37.60	13.79	10.50	1.42	76.14
3 rows 6 feet wide	9.81	2.56	28,140	36.05	14.03	10.30	1.73	73.41
3 rows 7 feet wide	9.37	2.59	27,560	35.66	14.63	11.40	1.42	77.92
3 rows 8 feet wide	....	2.76	25,564	35.15	14.26	10.50	1.69	73.63

Analyses of full grown but immature cane cut September 25 indicate that a ton of cane delivered at the mill removes from the soil 1.5 pounds nitrogen, 2.17 pounds potash, 1.48 pounds phosphoric acid, and 0.8 pound lime.

CULTURE.—The land is prepared with very large plows. The stalks of sugar cane are placed at the bottom of a furrow and covered. A single continuous line of canes is occasionally planted, but usually two or more stalks are laid side by side, making double, treble, or quadruple lines of plant cane. Two stalks have given better results than any other number. Late fall or early winter planting causes an earlier spring growth than spring planting and is therefore preferred. The stalks are usually cut into sections, so that in cultivation the planted stalks are not so easily plowed up. Experiments in cutting *vs.* not cutting plant cane showed a loss in tonnage from cutting. The same experiment repeated another season, but on cane from the stubble, showed injurious effects as the result of cutting the stalks into sections.

Cane rows are usually 5 to 7 feet wide. Experiments have resulted in a heavier tonnage from 3-foot rows than from any other, but proper cultivation of such narrow rows is impracticable and the amount of cane required in planting is very great. After making allowance for the extra amount of seed cane necessary, many experiments indicate that it would be economical to narrow the rows as far as is consistent with good cultivation (see table above).

Using two stalks and a lap, the following amounts of cane are required to plant an acre: In 3-foot rows, 9⅓ tons; in 4-foot rows, 7 tons; in 5-foot rows, 5.6 tons; in 6-foot rows, 4⅔ tons; in 7-foot rows, 4 tons.

It is customary to plant the whole stalk, but the Louisiana Station has shown that the upper portion of the stalk, the poorest for sugar-making, equals or surpasses the richer lower portion for seed. From experiments it seems that stubble cane is the equal, if not the superior, of plant cane for seed. Stripping off dead leaves during growth and preventing the growth of all shoots, except the original sprouts, have not given favorable results.

Sugar cane is given clean culture till June, when it is laid by.

Surface irrigation, subirrigation, and tile drainage all proved very profitable for cane in south Louisiana. The average of many experiments at Kenner, Louisiana, showed a gain of 672 pounds of sugar per acre, or 4.38 tons of cane, due to tile drainage.

MANURING.—The soil of the sugar belt of Louisiana is rich in potash, and hence this element in fertilizers has given no striking and immediate result. A combination of nitrogen and phosphoric acid is needed for sugar cane. An acre needs from 24 to 48 pounds of nitrogen, which can be most cheaply supplied in 350 to 700 pounds of cotton-seed meal. The nitrogen from sulphate of ammonia has been slightly more effective, but its cost prohibits its use. The soluble phosphates in combination with nitrogen have been slightly beneficial; 40 to 70 pounds of phosphoric acid per acre is the amount recommended. Pea vines turned under gave an increase, extending even to the second year's stubble. Plats from which pea vines had been cut for hay gave a good yield, but smaller than where vines were turned under.

An excessive quantity of nitrogen produces a heavy tonnage of low sugar content and of a character difficult to work up into sugar. At the Mississippi Station ashes used as a fertilizer increased the percentage of pure sugar.

ROTATION.—When properly fertilized a field may remain in cane for a number of years. Exhaustive crops should not precede cane. One of the best preparations for cane is a crop of peas, which should be turned under in the fall.

HARVESTING.—Sugar cane is stripped of its leaves, cut, and hauled to the sugar mill in November or December. The yield per acre at the Louisiana Sugar Station has usually been between 30 and 40 tons of cane, each ton yielding from 125 to 240 pounds of sugar, besides molasses. On poor upland, at Calhoun, Louisiana, and with a cheap mill, each acre in sugar cane gave 1,600 pounds of sugar and 106⅔ gallons of molasses, or a total value of $85.35 per acre.

SUGAR-MAKING.—Sugar is manufactured either by the roller-mill system or by the diffusion process. The plant for the latter is expensive, consisting of tanks, vacuum pans, centrifugals, etc. The advantage of the diffusion process over grinding lies in the more complete extraction of the sugar by the former process. The Louisiana Station, under the diffusion system, has extracted from 93.58 per cent to 96.10 per cent of the total sugar in the cane, and has secured more than 240 pounds of sugar from a ton of cane.

The apparatus for sugar-making on a small scale is described in *La. B. 5, 2d ser.* This outfit is said to cost from $50 to $300. Its essential parts are a roller mill (for horse power), a sulphur box, in which the juice meets the fumes of sulphur, and an evaporator or cooker. After sulphuring, the juice is neutralized with lime. After the juice has cooked to a thick sirup it is poured into a cooler. Here stirring induces graining, after which in another vessel the liquid portion, molasses, is allowed to drip or drain away the molasses. With this outfit at the Louisiana Station at Calhoun, each ton of cane yielded 132.08 pounds of sugar and 105.50 pounds of molasses.

(*Fla. B. 16; La. B. 7, B. 10, B. 14, B. 20, B. 23, B. 27, B. 28, and B. 5, B. 6, B. 7, B. 8, B. 9, B. 11, B. 14, 2d ser.; Miss. R. 1889, p. 20; S. C. R. 1889, p. 343.*)

Sulla (*Hedysarum coronarium*) [also known as Soola clover or French honeysuckle].—A perennial leguminous plant, somewhat resembling red clover. For analyses, see *Mass. State R. 1890, pp. 292, 297, R. 1891, pp. 316, 323.* At the Massachusetts State Station (*R. 1890, p. 174*) sulla made a healthy and vigorous growth, shading the ground well. It is proof against the average winter. At the Nebraska Station (*B. 6*) it made a small growth.

Sumac (*Rhus* spp.).—In *Cal. R. 1882, p. 108,* are notes upon the south European or tanner's sumac, *R. coriaria,* and incidentally upon American species. In view of the approaching exhaustion of the oak bark suitable for tanning in California, and of the rather low tannin content of the sumacs there native, it is deemed a matter of no small importance that the tanner's sumac will thrive in the State. "Its growth here in Berkeley has been astonishing, and it has proved itself hardy in the open air, even when very young." It is judged, therefore, that it will prove adapted to "the coast region of the State generally, its true place being no doubt on our poison-oak lands." It is easily propagated, pieces of subterranean runners readily forming plants in one season. Considerations are adduced tending to show that its culture would be profitable. It is pointed out that, notwithstanding a large consumption of the product of Eastern species, the price of the European sumac is still twice as great, the former containing a coloring matter which prevents its use for white leather. To the suggestion that this difficulty may be overcome by picking early in June, when the coloring matter is not present, it is objected that the foliage at that time is so full of water as greatly to increase the expense. The method of culture and handling the tanner's sumac as practiced in Europe is described.

Sunflower (*Helianthus annuus*).—An annual plant growing 10 or 12 feet high. Its showy flower head, with large yellow rays, contains numerous large seeds, which yield about 15 per cent of oil, used for adulterating olive oil, and for other purposes. The seeds are also used as food for animals. The New York State Station planted sunflower seed in hills 42 by 44 inches apart, four kernels to the hill. The culture was the same as for corn. The yield of seed was 50 bushels, or 1,150 pounds per acre. The air-dry seed contained 20.50 per cent of fat and 15.88 per cent of albuminoids. Drying the heads under cover is recommended.

Superphosphates.—See *Phosphates.*

Sweet corn (*Zea mays* var.).—See also *Corn.* The varieties of this group have often been considered chiefly in tests of their merits for the table, but also somewhat with reference to use as forage.

VARIETIES.—Tests are recorded in *Colo. R. 1888, p. 150, R. 1889, pp. 32, 102, 121, R. 1890, pp. 197, 210; Conn. State R. 1889, p. 232; Ill. B. 4, B. 8, B. 13; Ind. B. 18, B. 31,*

B. 34, B. 38; Ky. B. 32, B. 38; La. B. 3, 2d ser.; Me. R. 1890, p. 103; Mass. Hatch B. 7; Mich. B. 57, B. 70, B. 79; Minn. R. 1886, p. 340 R. 1888, p. 243; Nebr. B. 12, B. 19; Nev. R. 1890, p. 19; N. Y. State R. 1882, p. 135, R. 1883, p. 47, R. 1884, p. 156, R. 1889, p. 320 R. 1890, p. 287; N. C. B. 74; Ohio R. 1884, p. 139, R. 1885, p. 123, R. 1886, p. 178, R. 1887, p. 243; Pa. B 10, R. 1888, p. 145; Tenn. B. vol. III, 2; Utah B. 3, B. 12; Vt. R. 1889, p. 135, R. 1890, p. 157.

In the Connecticut tests for 1889 seed of two varieties from Eastern and Western sources was compared, the data including analyses of the product. The Massachusetts Hatch test of 1890 also included Eastern and Western seed of three varieties, and analyses for sugar content of all varieties are given. No very distinct conclusions were obtained in either case. In *N. Y. State R. 1884, p. 156*, full descriptions are given of 33 varieties, which are classified according to size of ear stalk, form of kernels, color of cob and kernels, etc. *Ill. B. 4, B. 8,* and *B. 13* give the results of extensive garden tests of varieties. Full descriptions are given with classification as early, medium, or late, and according to color of ear. In the last of these bulletins a revision of the previous grouping is made so as to bring together all varieties which were substantially alike, and 49 were still found distinct enough to be left separate. The synonyms are given with the descriptions.

COMPOSITION.—See *Appendix, Tables I and III.* Analyses with reference to sugar content are given in *Mass. Hatch B. 7; Mass. State R. 1891, p. 336.*

In *Me. R. 1889, p. 287,* the manurial and food ingredients of four lots of sweet corn are given for stalks, husks, kernels, and cobs, separately. The kernel was found to contain only about 21 per cent of the total phosphoric acid, 22 per cent of the potash, and 41 per cent of the nitrogen, showing that the kernel might be sold, and yet a large part of the fertilizing ingredients retained on the farm.

The successful crossing of sweet and flint corn is noted in *Ohio R. 1883, p. 64.* An experiment with fertilizers on sweet corn is reported in *N. H. B. 10.*

Germination tests of the seed are recorded in *Ill. B. 8; Me. R. 1888, p. 141; Mich. B. 57; N. Y. State R. 1883, p. 68; Ohio R. 1885, p. 153; Ore. B. 2.*

Sweet potato (*Ipomœa batatas*).—Variety tests are reported as follows: *Ark. R. 1889, p. 91, R. 1890, p. 123; La. B. 13, 2d ser.; Nebr. B. 12, B. 19; N. Y. State R. 1889, p. 326, R. 1890; p. 296; N. C. B. 74.*

In *La. B. 13, 2d ser.*, descriptions are given of 14 varieties, of which the forms of leaves are figured. These are placed in four classes, according to form of tubers (which are figured) and according to quality, as mealy or sugary. In the test at this station, besides yield and size of tubers for 14 varieties, the effects of frosts on the vines were observed.

The tests in New York were to answer the question whether the sweet potato could be successfully grown in that State. The results at the station and in trials made by farmers were quite favorable. Directions for culture are given. A trial in Colorado (*R. 1890, p. 205*) indicated profit in growing sweet potatoes in that State also.

COMPOSITION.—Analyses of the vines of two varieties occur in *Ga. B. 4;* of vines and tubers together for each of five varieties, *Ark. R. 1890, p. 125;* of vines and tubers separately for five varieties, *Ga. B. 13;* of tubers of fourteen varieties, *La. B. 13, 2d ser.;* of tubers showing the effects of different fertilizers, *N. J. R. 1892, p. 132.* The nutritive ratio for the vines as determined at the Georgia Station (*B. 4*) was about 1:5.89. The analysis of the vines, as judged at the Arkansas Station, showed them to be very va'uable as food for stock, by which also they were found to be relished at all times. (See *Appendix, Table II.*)

CULTURE.—In *Ala. College B. 5 (1887)* it is urged that the sweet potato is the root crop suited to the cotton States instead of the turnip and beet, so much advocated in the North and in Europe. At this station (*B. 31, n. ser.*) the results of planting large *vs.* small seed justified the use of the former. At the Arkansas Station (*R. 1890, p. 127*) high and low culture were compared, the result favoring the latter.

Removing four-fifths of the vines when well grown resulted in a large loss to the crop.

In *Ga. B. 11* and *B. 17* methods of culture are discussed in some detail with recommendations. Experiments in planting at different distances favored the distance of 2 by 3½ feet, 2¼ by 3½ following closely. Hill and flat culture were also compared (*B. 17*), with the advantage on the side of the latter. The difference in the result from planting large and small tubers was very small. Experiments at the Louisiana Station (*B. 13, 2d ser.*) indicated that plants must be set at least 15 inches apart in the row for maximum yield. Some cultural notes occur in *N. J. R., 1891, p. 124.* Directions for sweet-potato culture are given in *N. Y. State R. 1889, p. 326.* At the Tennessee Station (*B. vol. III, 1*) the results of several earlier and later plantings were compared, showing for those made from May 18 to June 1 a larger yield with less unmerchantable tubers than for those made from April 27 to May 11.

MANURING.—Experiments with fertilizers on sweet potatoes are recorded in *Ala. College B. 5 (1887), B. 3, n. ser.; Ark. R. 1889, p. 91, R. 1890, p. 127; Del. B. 11; Ga. B. 11, B. 17; La. B. 27 (North La. R. 1889, p. 488), B. 8, 2d ser., B. 13, 2d ser.; N. J. B. 34, B. P, R. 1883, pp. 16, 57, 96, R. 1890, p. 150, R. 1891, p. 124.*

STORAGE.—The preservation of sweet potatoes has been somewhat investigated, especially at the Georgia Station. In view of the successful experience of a citizen of the State in preserving sweet potatoes in a pit under glass upon a floor with another floor above where they had light and air, similar conditions were secured for trial at the station (*B. 2, B. 3*), a similar pit being prepared and use being made also of a dry well. Of the potatoes placed in the pit November 23, all but 7 per cent were sound April 1, but of those in the well nearly all were lost. The conditions of temperature and moisture were much the same, but there were some differences in circumstances of digging and amount of light. The subject was deemed to require further investigation, and experiments with other methods, as noted in *B. 11, B. 17,* have also been undertaken. At the New York State Station (*R. 1890, p. 296*) tubers packed in dry road dust and kept at a temperature of 60° continued fit for the table till after the middle of January. At the South Carolina Station (*B. 5, n. ser.*) experiments were made in keeping small quantities of sweet potatoes packed with various materials in barrels. The materials used were sand, cotton seed, cotton hulls, damaged lint cotton, wheat bran, newspapers, and hay, of which dry sand and cotton hulls gave the best results. "Wrapping each potato with paper induced rapid decay," but "a double lining of paper next the barrel was fairly effective in keeping out cold and preventing rot." The keeping qualities of large and small tubers appeared about equal.

In *Ark. R. 1890, p. 127,* where the tops of sweet potatoes are recommended for feeding stock, it is advised that they be ensiled, as they do not cure readily into hay.

Sweet potato, black rot (*Ceratocystis fimbriata*).—A potato affected with this fungous disease will exhibit one or more dark brown patches of irregular outline. The spots spread with considerable rapidity, and when about an inch in diameter the center breaks up in an irregular way. This fungus is usually present at digging time, but is then so undeveloped as to pass unnoticed. It is very different from the soft rot, in that it is dry and inoffensive. Its spread is worst after digging, and any cut or bruised place will furnish a good place for its attack. This disease takes on several forms, and each is supplied with spores for its rapid spread. In every case the spores are formed underground, and how long they can retain their vitality is unknown. Wherever black rot is bad sweet potatoes should not be planted for some time. It is important also that healthy sets should be used. The seed potatoes and young plants might be advantageously treated with fungicides in the hotbed. It is well established that plants grown from diseased "seed" will spread the disease. All the spores of the fungus may be killed by heating the soil of the bed to a high temperature for several hours. This method of sterilization is only applicable to hotbeds. (*Del. R. 1890, p. 90; N. J. B. 76, B. M.*)

Sweet potato, dry rot (*Phoma batatæ*).—A fungous disease, in which the upper end of the root becomes dry and wrinkled, and numerous small pimples appear over its surface. The whole substance of the potato is attacked, and the usually plump, juicy tissue is replaced by a dry powder, making the root worthless. A rotation of crops, care in selection of seed, and the destruction of all diseased refuse are advised as preventive measures for this and other diseases of sweet potatoes. (*N. J. B. 76.*)

Sweet potato, leaf blights.—The disease caused by the fungus *Phyllosticta batataticola* confines itself to the leaves of the sweet potato, and is troublesome in proportion to its abundance. It is distinguished by spots which are small at first but increase and coalesce until a considerable portion of the leaf is involved.

Another disease of the leaves of the sweet potato is the leaf mold, caused by the fungus *Cystopus ipomϾ-panduranæ*. With this disease the leaves first lose their deep green color, and are more or less covered with brown patches which soon become dead and nearly black. Upon the under side there may be seen small patches of a whitish color. These places are where the skin is broken and multitudes of spores are escaping. There is another form of this fungus which is said not to grow on the cultivated sweet potato but the wild sweet potato or morning glory, sometimes called Man-of-the-earth. This fungus produces gall-like bodies, filled with spores by which to carry itself over the winter. All such plants should be exterminated as a precautionary measure. The use of any of the more common fungicides will no doubt prove beneficial in the case of both these diseases. (*N. J. B. 76.*)

Sweet potato, soft rot (*Rhizopus nigricans*).—A fungous disease most abundant in the storeroom. It is liable to show in spots where the skin has been broken by digging or hauling. The potato becomes softened at the point of attack. From this point it spreads very rapidly until the whole becomes a soft, worthless mass. It may sometimes be present at the time of digging, but not usually. Dampness aids in the rapid growth. Sweet potatoes should be kept in an airy, dry room, at about the ordinary temperature of a living room. Above all they must be kept dry. (*N. J. B. 76.*)

Sweet potato, soil rot (*Acrocystis batatas*).—This is one of the most destructive as well as least understood of the sweet potato diseases. It is known to attack the potato only through the very small rootlets, not being able to penetrate the epidermis of the larger roots. The infested portion ceases to grow and the result is a small deformed root. Where the soil has become thoroughly infected it is almost impossible to grow this crop until several years have intervened. It is thought the character of soils and fertilizers may have something to do with the rapidity of growth and spread of this fungus, but of this little is known. (*N. J. B. 76, B. M.*)

Sycamore (*Platanus* spp.).—An investigation of the fuel values of several native woods by the Georgia Station (*B. 2*) included that of the American plane-tree, or sycamore (*P. occidentalis*). A full ash analysis is given. For analysis showing fertilizing constituents of ash see *Appendix, Table V.*

The "oriental sycamore" (plane-tree) is noted in *Cal. R. 1885–'86, p. 121*, as "a beautiful straight-growing tree of very rapid growth, seemingly well adapted to our climate. For avenues and street planting it is well suited. The timber is valuable and used for furniture and other cabinet work."

Sylvinite.—See *Potash.*

Syrphus flies.—Small two-winged, rapid-flying flies, the larvæ of which are very destructive to plant lice. The larvæ are maggots resembling leeches in shape. In color they are usually rather green, becoming grayish as they grow older. They are very active in their search for plant lice, the juices of which they suck. As their appetites are always good and their feeding capacity nearly unlimited they destroy very many lice in a short time, making them especially valuable in protecting the grain crops. (*Mich. R. 1889, p. 251; Nebr. B. 14; N. J. R. 1890, p. 502.*)

Tamarind (*Tamarindus indica*).—The tamarind as tested at the California Berkeley Station (*R. 1880, p. 67*) did not make much progress either outdoors or indoors.

Tankage.—The dried residue from tanks in which fat has been rendered. (See *Fertilizers* and *Appendix, Table V.*)

Tares.—See *Vetch.*

Taro (*Colocasia antiquorum* var. *esculenta*).—This food-plant of the Pacific islands, besides being cultivated for ornament here and there in California, has given some signs of attaining economic importance. In *Cal. B. 95* an account is given of its qualities and the method of growing it, and tubers are offered for distribution. "The tuber or corn is highly palatable and nutritious either boiled, baked, or made into bread. The leaves are also said to be palatable cooked as spinach." Taro may be grown in common garden soil or in wet places, even enduring complete submergence.

Tennessee Station, Knoxville.—Organized by the trustees of the University of Tennessee June 8, 1882, and reorganized under act of Congress in 1887 as a department of the University of Tennessee. The staff consists of the president of the college, director and botanist, assistant director, chemist, agriculturist, horticulturist, and assistant chemist. The principal lines of work are botany, soils, field experiments with fertilizers, field crops, vegetables, and fruits, and feeding experiments. Up to January 1, 1893, the station had published 2 annual reports and 27 bulletins. Revenue in 1892, $15,000.

Teosinte (*Euchlæna luxurians*).—A grass of tropical nativity, closely allied to and somewhat resembling Indian corn. It is said to have been introduced into this country from Central or South America, although it was first cultivated in Australia. In its native habitat it grows freely, often attaining a height of from 10 to 15 feet in a few months. It "suckers out" or "tillers" to a remarkable degree, often as many as thirty to fifty suckers springing from a single stalk. In this country the climate is not hot enough nor are the seasons long enough to ripen the seed, except in a very few places. It is a tall and rapidly growing plant, having a large number of long leaves, greatly resembling the blades of corn. Teosinte, while requiring a semi-tropical climate to mature its seed, will do well as a forage plant as far north as Kansas and Pennsylvania. (*Kans. B. 18, R. 1888, p. 65, R. 1889, p. 43; Pa. R. 1888, p. 44.*) In Michigan it has been grown 4 or 5 feet high, with stalks small and leaves long and narrow. It was there planted too close or it might have done much better. It was tried in Vermont, but did not give satisfaction (*Vt. R. 1888, p. 15*). In Kansas it has been tested for several years and is well liked as a forage plant. It stands drought very well, much better than corn, and the yield is enormous, the average annual crop for three years at the Kansas Station having been a little more than 23 tons of green forage per acre. It is of especial value as a green fodder when other forage is dried up. Stock of all kinds seem fond of it. There is no waste either when green or dry, as the stalks are tender, and cattle eat leaves and all. In Kansas two crops may be cut in the course of a season, but the best results are obtained by a single cutting in September, before there is any frost. It should be planted in rows 3 feet apart and thinned until the plants are about a foot apart. To plant in this manner one pound of seed will be required for an acre. When so planted, it will often sucker out until twenty or more stalks are borne on a single stool. (*Kans. B. 18, R. 1888, p. 65, R. 1889, p. 43.*) In Texas it has given good results wherever tried, as both a green and a dry forage. The quality and quantity equal, if they do not exceed, any other forage plant. It is said to be perennial in its native region, but experience has shown that it must be treated as an annual in this country. It grows to a height of 9 feet in Texas and produces three crops a year, but does not mature its seed (*Tex. B. 3, B. 13, R. 1888, p. 42*). In Louisiana it has been grown to a considerable extent and in some parts has matured seed (*La. B. 8, 2d ser., R. 1891, p. 11*). Three crops are usually cut, but a single cutting between September 15 and 30 will be found to give a yield of superior quality, and the quantity will be but little less than the total for three cuttings. In Georgia the yield is

about 19 tons per acre on the average and the fodder is considered of a superior quality (*Ga. B. 12*). At the Oregon Station (*B. 4*) teosinte is not a success, but is said to do fairly well in the southern part of the State.

Analyses of teosinte are given in *Mass. State R. 1889, pp. 178, 299, R. 1891, pp. 316, 322; Tex. B. 13; Ga. B. 12; O. E. S. B. 11.*

Texas blue grass.—See *Grasses.*

Texas fever.—See *Southern cattle fever.*

Texas Station, College Station.—Organized under act of Congress January 25, 1888, as a department of the Agricultural and Mechanical College of Texas. The staff consists of the president of the college, director and agriculturist, chemist, veterinarian, mycologist and assistant chemist, assistant agriculturist, assistant to director, and assistant chemist. The principal lines of work are field experiments with field crops, vegetables, and fruits; diseases of plants; feeding experiments; veterinary science and practice; and dairying. Up to January 1, 1893, the station had published 4 annual reports and 25 bulletins. Revenue in 1892, $18,972.

Thistles.—See *Weeds.*

Thomas slag.—See *Phosphates* and *Fertilizers.*

Timothy.—See *Grasses.*

Tobacco (*Nicotina tabacum*).—An annual plant growing from 3 to 6 feet high, with large ovate leaves sometimes 2 feet long and 1 foot wide.

In 1889 the United States produced 488,225,896 pounds of tobacco. Of this amount Kentucky produced 45.44 per cent. The other principal tobacco-growing States are North Carolina, Virginia, Ohio, Pennsylvania, Tennessee, Wisconsin, and Connecticut.

VARIETIES.—There are many varieties of tobacco, and the proper choice between these depends on the character of the soil and climate and on the market. The following are recommended by the Alabama Station:

"For dark, heavy, rich shipping, the James River White-stem, James River Blue Pryor, and Medley Pryor; * * * for sweet fillers, Sweet Ornico, and Flanagan; for stemming into strips for the European market, Hester, Tuckahoe, and Big Orinoco; for mahogany wrappers, Flanagan, Primus, and Long-Leafed Gooch; for cutters, Hyco, Yellow Orinoco, Granville Yellow, Yellow Pryor; for yellow wrappers and fillers, Sterling, Granville, White Stem, Yellow Orinico, and Yellow Pryor." White Burley is largely grown on limestone soils. *Colo. B. 10* states that Havana Seed Leaf is best for that State. In Colorado the White Burley matured earliest and was easily cured. Other cigar tobaccos, easily handled, were Connecticut Seed Leaf, Vuelta Abajo, and Missouri Broad Leaf. The Florida Station states that cigar tobacco of excellent quality has been grown on the station farm.

COMPOSITION.—Analyses reported in *Va. B. 14* indicate that a crop yielding 1,000 pounds of leaf tobacco contains the following amounts of fertilizing constituents in the entire plant: Nitrogen, 66.75 pounds; phosphoric acid, 8.68 pounds; potash, 85.41 pounds; lime, 68.94 pounds.

(See also *Colo. B. 10; Conn. State R. 1884, p. 97; Ky. R. 1888, p. 27; N. Y. State B. 71 (1883).*)

CULTURE.—*Preparation of seed bed.*—Tobacco seeds are planted in hot beds, cold frames, or open-air beds, according to the time when sown and the climate of each locality. The young plants are sensitive to cold, and hence in the seed bed usually require the protection of brush, cloth, or glass. Newly cleared land, well drained, but not deficient in moisture, is preferred for the seed bed, since it is more nearly free from grass and weed seeds than old land. But clean cultivated land, made very rich with well-rotted manure, or with fertilizers, will answer. All manure applied to the seed bed should be free from grass seed, and should be applied about a month before the tobacco seed is planted. Still further to destroy weed seed and to furnish

a potassic fertilizer, the bed should be burned. This is done by building on the spot a fire of brush or wood, letting it burn about an hour in one place and then drawing the fire on to another part of the bed. Avoid burning when the ground is wet. After the ashes cool all lumps of charcoal are raked off. If a large bed is to be prepared it may be broken both ways with the colter. For a small bed on new ground an old ax may be used, cutting into the ground till the bed is divided by the ax furrows into sections about 6 inches square. In this way all roots are cut into pieces about 6 inches long. The soil is then fined with mattock or rake, and all roots are taken from the bed and manure worked in. In all of this preparation the subsoil should not be brought to the surface. For an open-air bed or cold frame, boards should be placed around the bed, making the frame about 20 inches high on the north side and 10 inches on the south side. A covering of thin cloth is then put on and held in place by various devices.

Sowing the seed.—Different amounts of seed are recommended by various authorities. *Ala. College B. 37* and *N. C. B. 86* recommend one tablespoonful for every 100 square yards of seed bed. A good stand means about 1,000 plants per square yard (*Ala. B. 37*). A later sowing will guard against the calamities which so frequently destroy the young plants. Avoid seeding too thick or the plants will be dwarfed. The seed is mixed with ashes, or other light colored substance, and usually sown broadcast over the surface. Sowing half the seed in one direction and then cross-sowing the remainder will secure an even distribution of seed.

The seeds are covered by whipping the soil with a light brush, by tramping with the feet, or by rolling. Fine brush, placed on the bed after the plants are up, serves to protect from frost and to preserve the moisture in the soil. The bed must be well drained, and all drains should be so arranged that no water can flow over any of the seeded surface, since the drift would cover the seed too deeply.

Date of seeding.—The date of seeding varies with the latitude. The aim is to sow as early as possible without subjecting the plants to excessive cold. Late sowings suffer most from insect ravages. In Florida the seed may be sown as early as January 1. In Virginia, the middle of February is an early date for sowing. In Colorado seeding about April 1 in hot beds was successful.

Treatment of young plants.—The seed bed should be located near a water supply, as it is necessary, by frequent waterings, to keep the plants growing rapidly. When the leaves are as large as a quarter of a dollar the cover of the frame is removed, or it may be removed sooner if the seed has been sown late and the weather is warm. Applications of dilute liquid manure will hasten the growth, or other manures may be applied when the leaves of the plants are dry. If glass has been used as a covering of the seed bed, it is especially important that the plants should be gradually hardened before transplanting.

Preparation of the field.—Prepare the land, as for a garden, by several plowings and harrowings. Lay off the rows about 3½ feet apart, applying the fertilizer in the drill, and with turn-plow throw up beds above the fertilizer. On heavy soils, hills about 3 feet apart are formed with the hoe. On sandy soils, the elevated bed is sufficient. The distance at which plants should be set varies with the variety grown, with the character of the soil, and with the climate. At greater distances than indicated above, tobacco increases in size and coarseness. When more crowded, the size and weight of tobacco are decreased, while silkiness and closeness of texture are gained. The Colorado Station recommends 3 feet by 2 feet for Havana varieties, or 4 feet by 3 feet for the larger kinds.

Transplanting.—A tobacco plant should have leaves at least as large as a silver dollar before it is set in the field. The proper time for transplanting is when the largest leaves are about 2½ inches wide. If possible, choose showery weather; but by watering after transplanting, tobacco plants may be set out in dry weather. One man drops the plants at regular intervals and another following sets the plant in a hole made by a sharpened stick, pressing the earth firmly about the roots.

The plant bed must be thoroughly wet before the plants are drawn. The season for transplanting varies with the latitude, from April to June.

Cultivation.—As soon as the plants are firmly rooted the earth near the hill is cultivated with a hoe. During the season the plow may be used in several cultivations, but after the tobacco plants have attained considerable size only hoe cultivation is practicable.

Topping, priming, and sprouting.—As soon as the buttons, which would develop into blossoms, appear topping is in order. This consists in pinching off with the finger nails the flower shoot and some of the upper leaves of the plant. Priming or pruning, which is done at the same time as topping, consists in taking off 4 or 5 of the bottom leaves. On the bright varieties these lower leaves are sometimes allowed to remain as a protection to the other leaves.

The number of leaves left after topping and priming varies from 8 to 13, according to the class of tobacco. The smaller number of leaves gives a heavier, stronger grade of tobacco. After topping, sprouts or suckers put out from the axis of every leaf. To break these off and to pick off the worms, which at that season are plentiful, the laborers must go over the crop at least once every ten days.

MANURING.—In *Conn. State R. 1884, p. 104,* the following statements occur:

"It would be going too far to assert that the use of chlorides (muriates) of fish or slaughter-house fertilizers *must invariably* produce tobacco of inferior quality. * * * The tobacco-grower will, however, do well to avoid the use of the above-named fertilizers, which experience in all countries agrees in indicating to be as a rule likely to injure the burning quality of the leaf." *Colo. B. 10* quotes European authorities on the same subject. "Their [Schloesing's and Nessler's] experiments show that potash salts, sulphates, and carbonates act beneficially upon the quality, while the chloride injures it." At the Kentucky Station nitrate of soda gave a little larger yield of tobacco than did cotton-seed meal or sulphate of ammonia. *Ky. B. 28* also states, as a result of experiments on the soil of the experiment farm, that 160 pounds of the nitrate of soda per acre or 340 pounds of cotton-seed meal furnished sufficient nitrogen for the tobacco crop. The conclusion was also reached that more than 160 pounds of either sulphate or nitrate of potash would increase the yield. The muriate gave the larger crop. No test was made as to the effect of the various potash salts on the burning quality of tobacco. In this series of experiments every fertilizer used, nitrate of soda, acid phosphate, and sulphate of potash, and every combination but one, afforded considerable net profit. The highest net profit resulted from the use of a complete fertilizer, and was nearly equaled by the profit on a plat fertilized with sulphate of potash and nitrate of soda.

The following table embodies the results secured by a Virginia tobacco-planter, R. L. Ragland, of Halifax County, who conducted the experiment for the Virginia Station.

Effects of different fertilizers on tobacco.

No. of plat.	Kinds of fertilizers.	Amount per acre.	Yield of the various grades per acre. Best leaf.	Second leaf.	Third leaf.	Best lugs.	Second lugs.	Total produce.	Financial results. Cost of fertilizers per acre.	Value of tobacco per acre.	Value of increased yield per acre.	Profit per acre.
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*				
1	Sulphate of ammonia Dried blood Sulphate of potash Acid phosphate	50 80 120 114	105	367	130	135	298	1,035	$8.25	$131.20	$45.22	$36.97
2	Nitrate of soda Dried blood Sulphate of potash Acid phosphate	72 80 120 114	105	253	186	115	354	1,013	8.25	127.90	41.92	33.67
3	Dried blood Sulphate of potash Acid phosphate	160 120 114	170	363	112	121	280	1,046	8.25	146.60	60.62	52.37
4	Nitrate of soda Sulphate of potash Acid phosphate	143 120 114	127	278	123	140	250	946	8.25	130.14	44.16	35.91
5	Sulphate of ammonia Sulphate of potash Acid phosphate	100 120 114	100	269	160	94	267	887	8.25	109.63	23.65	15.40
	Unfertilized		44	240	66	132	280	762	......	85.98	......	......

Dried blood not only gave the largest yield, but the color of tobacco on that plat was brighter during growth and after curing. There was less field-fire where dried blood and nitrate of soda were used, separately or in combination, than where no fertilizer was applied. The unfertilized plat had by far the most stalk rot or "hollow stalk." In every case the use of a complete fertilizer was profitable.

Rotation.—Wheat is frequently sown after tobacco (*N. J. R. 1882, p. 97*). The North Carolina Station suggests that crimson clover should be sown after tobacco. The crops preceding tobacco in a rotation should be of such kind as draw the least potash from the soil.

Curing.—From eighty to one hundred and twenty days after transplanting the plants are ready for harvesting. When ripe enough to cut, the leaves have turned to a light shade of green or greenish yellow, and have become thick and brittle, so that the leaf cracks when folded together between the thumb and finger.

With a large knife the stalk is split about two-thirds of the way to the ground, and is then cut off several inches below the split portion. After wilting in the field so as to become limber, 8 or 10 stalks are strung on a stick about 4½ feet long, the split stalk straddling the stick, leaves hanging down.

These sticks, with their burdens, are laid across joists in the tobacco barn—a tall, closely built structure. Barns may be built for from 1 to 5 or more tiers. Heat from furnaces is conveyed by two sheet-iron return flues, about 12 inches in diameter, which are near the floor. The fires are kept up night and day for two to four days. There are several methods—or, rather, heat formulas—for curing tobacco, one of the most popular of which is the Ragland method, in which the temperature of the barn is regulated as follows:

(1) *Sapping process.*—90° F. for two to three hours, then advancing rapidly to 125°, to remain only a few minutes; then cut off heat and descend to 90°.

(2) *Yellowing process.*—90° for twenty-four to thirty hours.

(3) *Fixing color.*—100° for four hours; then increasing 2½° every two hours; then 110° to 120° for four to eight hours.

(4) *Curing the leaf.*—120° to 125° for six to eight hours.

(5) *Curing stalks and stem.*—125° to 170°, by an increase of 5° each hour. Continue at 170° for twelve to fifteen hours.

While the above is a standard method, expert tobacco curers diverge from it whenever the eye and touch indicate the need of a different temperature.

Tobacco is also cured by the direct heat of charcoal and by sun curing.

After curing, by the Ragland or some similar method, the tobacco is taken down from the barn and bulked. Before marketing the leaves are stripped from the stalks, assorted, and tied into bundles. It is further manipulated in the tobacco factory and comes out as cigars, plug tobacco, smoking tobacco, etc.

More recent and less extensively used than the stalk-cure method just described is the system of leaf cure. In this the leaves, as they ripen, are broken from the growing plant, tied into bundles, and cured by flue heat in a tobacco barn. The North Carolina Station (*B. 86*) reports an experiment comparing the two systems. The product from half an acre, with the stalk cure, was 326.25 pounds of tobacco, worth $38.29. From the same area the leaf cure gave 454 pounds, worth $68.14. The cost of curing the half acre by the stalk-cure process was $5.40; by the leaf-cure method, $9.59, which leaves considerable financial margin in favor of the leaf-cure system. See also *Conn. State R. 1891, p. 176.*

TOBACCO STEMS.—This waste product of a tobacco manufactory is rich in potash, and contains considerable nitrogen and phosphoric acid. As a fertilizer for corn it proved valuable in Kentucky (*B. 17*). (See also *Conn. State R. 1889, p. 114; N. C. B. May, 1883, R. 1888, p. 53.*)

(*Ala. College B. 37, n. ser.; Colo. B. 4, B. 10, R. 1888, p. 58, R. 1889, p. 123; Conn. State R. 1891, p. 168; Fla B. 12, B. 15; Ky. B. 28, R. 1888, p. 36; La. R. 1891, p. 18; Md. B. 5; Nebr. B. 6; Nev. R. 1891, p. 17; N. C. B. 86; N. J. B. A (1882), R. 1882, p. 92; N. Y. State B. 20 (1882); Va. B. 12, B. 14 (1892).*)

Tobacco, pole burn.—A fungous disease which greatly injures the tobacco crop in certain seasons. Damp, sultry weather, if of long duration, at the time of curing, will nearly always develop this disease. At first the disease is confined to the midrib and veins, but it soon spreads and causes considerable portions of the leaves to become black and brittle. If examined with a microscope fungi (a species of *Cladosporium*) will probably be found to be present, together with immense numbers of bacteria. It is thought probable that the bacteria develop after the fungi, and that they cause the pole burn. Pole burn may be remedied to a great degree, if not wholly prevented, by careful attention to the details of curing. The house should be arranged for ventilation and artificial heat, as well as to keep out the damp air when too abundant. Of course all moisture can not and must not be excluded, but it should be controlled. Various plans and suggestions have been made, the object of which is to hasten drying and prevent loss from pole burn and stem rot. (*Conn. State R. 1891, p. 168.*)

Tobacco, stem rot (*Botrytis longibrachiata*).—A fungous disease affecting the crop while drying. If stems affected with this disease are examined there will be found patches of a velvety white fungus. This spreads rapidly, especially along the veins of the leaves, causing more or less decay. The spores seldom ripen upon the stalks while hanging in the barn, but they will do so on the stalks which are thrown aside as worthless. All such infected stalks should be burned and the barn fumigated, before and after curing, with sulphur kept boiling for two or three hours while the barn is tightly closed. The sulphur may be boiled over a kerosene stove. (*Conn. State R. 1891, p. 184.*)

Tobacco worm (*Phlegethontius carolina*).—The adult insect is a large gray hawk moth often seen flying about Jamestown or Jimson weed in the dusk of the evening. There are usually two broods each year. The first brood works almost entirely upon

tobacco, the second on the tomato. The latter enters the ground and as a pupa spends the winter there. The grub or caterpillar is nearly 2 inches long, light green with white bands on the sides and a long horn on the posterior end.

The usual remedies are hand picking the worms and poisoning the moths, which sip the nectar from the Jimson flowers with their long proboscides. If a half teaspoonful of sweetened water containing a little Paris green be placed in the flowers a little before dusk, many moths will be poisoned.

Many growers plant seeds of the Jimson weed with their tobacco for this reason. (*Ky. B. 40; N. C. B. 78; S. C. R. 1888, p. 36.*)

Tomato (*Lycopersicum* spp.).—The tomato has apparently been more widely and thoroughly investigated at the stations than any other garden vegetable. This is owing to the immense demand for the fruit in the general market and for canning, as also its extensive domestic culture. The annual crop in New Jersey is estimated (*N. J. B. 63*) to be worth $1,000,000, and there are stated to be 73 tomato canneries in that State. With somewhat less definite statistics the Virginia crop is estimated (*Va. B. 4*) at the same figure, and the number of canneries wholly or partly devoted to tomatoes at 80 and perhaps 100.

Historical notes on the origin and introduction of the tomato by Dr. E. L. Sturtevant are given in *Md. R. 1889, p. 18,* with some classificatory matter and synonymy. In *N. Y. State R. 1887,* a classification according to species and main types by the same authority is given with full English and foreign, especially old, synonymy, descriptions of 65 varieties now current with their synonyms, and an index to all the names. The tomatoes of present cultivation are all referred to two species, *L. esculentum,* embracing the great mass of varieties, and *L. pimpinellifolium,* the currant tomato. The former has two main types, var. *cerasiforme,* the cherry tomato and var. *vulgare,* embracing the ordinary market tomatoes.

In *Mich. B. 48,* where a synopsis of 45 varieties is given, the same specific classification is used, but five main types under *L. esculentum* are recognized, viz, the cherry, the pear-shaped, the common (*vulgare*), the large-leafed, and the upright or tree. These are described and figured. This classification is also adopted in *N. Y. Cornell B. 32.* The cherry tomato is here taken as the probable starting point of the cultivated tomatoes, and the evolution of main types is traced from that point.

VARIETIES.—Tests are reported as follows: *Ala. College B. 2, B. 7, n. ser., B. 20, n. ser.; Ala. Canebrake B. 2; Ark R. 1889, p. 100; Colo. R. 1888, p. 133, R. 1889, pp. 41, 104, 119, R. 1890, pp. 41, 206, R. 1891, p. 207; Ga. B. 11, B. 17; Ind. B. 31; Kans. R. 1888, p. 271, R. 1889, p. 198; Ky. B. 32, B. 38; La. B. 16, B. 3, 2d ser.; Md. B. 5, B. 11, R. 1889, p. 26. R. 1891, p. 400; Mass. Hatch. B. 7; Mich. B. 48, B. 57, B. 70, B. 79; Minn. R. 1888, pp. 256, 261; Mo. B. 13; Nebr. B. 6; N. Y. State R. 1882, p. 138, R. 1883, p. 193, R. 1884, p. 221, R. 1885, p. 179, R. 1887, p. 328, R. 1889, p. 327, R. 1890, p. 297, B. 30, N. Y. Cornell B. 10, B. 21, B. 32; N. C. B. 72, B. 74; Ohio R. 1883, p. 139, R. 1884, p. 146, R. 1885, p. 134, R. 1886, p. 168, R. 1887, p. 231; Ore. B. 4, B. 7, B. 15; Pa. B. 10, B. 14, R. 1888, p. 150; Vt. R. 1889, p. 138, R. 1890, p. 178; Va. B. 4, B. 9, B. 11; W Va. B. 20.*

The upright or tree tomato, planted in many tests, is especially noticed in *Minn R. 1888, p. 256;* and in *N. Y. State R. 1886, p. 169,* the success is noted of an attempt to secure a cross having the habit of this variety, but yielding smooth fruit maturing early. The short life of varieties is remarked upon in *N. Y. Cornell B. 10,* where ten years is considered to be the average profitable period for varieties. In *N. Y. Cornell B. 21,* the effects of careful and persistent breeding on the station stock is noted as showing itself in great uniformity and remarkably regular and handsome fruits. In the station selections of seed, it is stated, greater consideration is invariably given to the character of the stock plant itself than to that of individual fruits, and facts are adduced justifying this course.

A scale of points for the ideal tomato, it is thought (*N. Y. Cornell B. 10, B. 32*), would be nearly as follows: Vigor of plant, 5; earliness, 10; color of fruit, 5;

solidity of fruit, 20; shape of fruit, 20; size, 10; flavor, 5; cooking qualities, 5; productiveness, 20.

A keeping test conducted two seasons is recorded in *N. Y. Cornell B. 32*. The small and unimportant varieties kept longest. Solidity did not seem to insure a good-keeping quality, nor did this quality seem to be very closely associated with varietal character.

SEEDS.—Germination tests are reported in *Ala. College B. 2 (1887); Ark. R. 1889, p. 95; Me. R. 1888, p. 141, R. 1889, p. 150; N. Y. State R. 1883, pp. 61, 71; Ohio R. 1884, p. 198, R. 1885, pp. 167, 173; Ore. B. 15; Pa. R. 1889, p. 164; S. C. R. 1888, p. 70; Vt. R. 1889, 109.*

COMPOSITION.—See *Appendix, Table III.* The physical characteristics of 28 varieties, *i. e.*, the percentage of flesh and the number of cells, are shown in *Md. B. 11, R. 1889, p. 34*. In general "the greater the number of cells in a fruit the higher is the percentage of solid flesh."

An analysis of tomato fruit occurs in *N. Y. State R. 1882, p. 24*. In *Md. R. 1889, p. 67*, are given determinations of sugar, acids, etc., for 66 varieties or strains; of food constituents for 6 varieties, with average of sugar, acids, etc., for two samples from each of eleven plats differently fertilized and one not fertilized, and average for each treatment; of sugar, acid, moisture, etc., for samples taken on fourteen days, placed in comparison with the weather record; and a comparison of acid and sugar determinations of fresh fruit and dry substance. The last was regarded as making it evident that there was a loss or change of both sugar and acids in the process of drying. In *Md. B. 11* approximate estimates are given of the quantities of the three fertilizing ingredients per acre removed by this crop, and of the amounts of the same left per acre in the roots and stubble of this and several crops. It appeared that the tomato is not an exhausting crop as compared with others. In *N. J. B. 63* are given analyses with reference to food and fertilizing constituents of 12 samples of tomato fruit from as many plats differently fertilized. The fertilizing ingredients are shown in amounts removed per acre, and a comparison is made in this regard with sweet and white potatoes and several cereal crops. *Va. B. 4* contains analyses showing food constituents of the fruit and fertilizing constituents of the vines.

CULTURE.—At the New York State (*R. 1884, p. 223, R. 1885, p. 181*) and Ohio Stations (*R. 1885, p. 134*) the testimony of experiments with regard to earliness was found quite irregular, many of the so-called varieties being merely strains, with the character not well fixed.

At the Ohio Station (*R. 1883, p. 140, R. 1885, p. 134*) it was observed that the finest, if not the earliest, fruit was secured by selecting seed from the first good fruits, or from plants giving the most early fruits. At the Michigan Station (*B. 48, B. 57*) there was a slight apparent gain in the angular sorts from selecting seed from first ripe fruit, and a slight apparent loss in the smooth varieties; but it was judged that little was to be gained by such selection. The effect of using immature seed was tested at the New York State Station through several years (*R. 1884, p. 224, R. 1885, p. 182, R. 1889, p. 329, R. 1890, p. 299.*) The degree of greenness at which seed would germinate seemed rather remarkable. The green seed was found to mature its fruit earlier, but the vigor of the plant was impaired. In one case immature seed from plants grown from immature seed was taken. At the Wisconsin Station (*R. 1891, p. 152*) the experiment was also taken up with similar results. Here seed was employed which had been selected from ripe and unripe fruit through six generations. The effects upon fruit, vines, and seed are stated in detail, with some graphic illustrations. It did not appear that the feebleness of the plants increased after the third generation. As practical lessons it was suggested that the tomato might be rendered more productive and earlier by a treatment reducing the native vigor of the plant as by growing on poor, dry soil, etc.; and that the health of the plants is dependent in a measure upon the quality of the seed used. At the New York Cornell Station (*B. 32*,

B. 45) little appeared to be gained by selecting seed from first ripe fruit without regard to the character of the plant.

Frequent or at least some transplanting of seedlings to secure stocky plants is recommended in *N. Y. Cornell B. 21, B. 32, B. 45; Va. B. 4, B. 9.* Experiments were made at the Maryland Station (*B. 11, R. 1891, p. 407*) comparing pot-grown plants for setting with those transplanted in the ordinary way, with results regarded as decidedly in favor of the former. Tin cans with both tops and bottoms melted off were used There was no wilting or checking of growth, and the pot-grown plants produced more fruit than the transplanted, a large part of it earlier in the season. At the New York Cornell Station (*B. 10*) a decided advantage in earliness and yield, with stocky and vigorous plants, was gained by early planting under glass. At the New York Cornell Station (*B. 21, B. 32, B. 45*) experiments were made resulting in favor of early setting of plants in that latitude. The first year, though the plants were set in cold, wet, and dark weather, they gave earlier results than those set when the weather was settled, and nearly five times as large a yield. The second year, when the weather was cold and dry, the advantage was on the same side, but less striking. At the same station (*B. 21, B. 32, B. 45*) tests of cuttings as compared with seedlings have given conflicting results. A method of setting tomato plants economically on a large scale is described with figures in *Va. B. 9, B. 11.* The plants are dropped in open furrows about 5 inches deep, being placed against the vertical side, and are covered with a hoe.

The supporting of tomato vines on a stake, frame, trellis, or platform has been tried as reported in *Ky. B. 32; Mich. B. 79; N. Y. State B. 30, R. 1890, p. 297 N. Y. Cornell B. 32.* Some form of support is in all cases approved, at least for garden practice. Of several different devices used at the Michigan Station, a pair of wires fastened to each edge of 6-inch fence boards seemed the most available. At the New York Cornell Station a wooden rack with parallel slats on each side the row, and other pieces laid across, was found to give good results. Trimming the vines has been tried at the Kentucky (*B. 32*), New York State (*R. 1890, p. 297*), and New York Cornell Stations (*B. 21, B. 32*). Conclusions were rather favorable to the practice, at least in gardens for home supply. At the Kentucky Station the fruit from trimmed vines appeared to be of better quality. Training to a single stem supported by a stake, according to *N. Y. Cornell B. 32, B. 45*, "greatly increases the yield per square foot, gives earlier fruit, and decreases the injury from rot"

Attention has been given at the New York Cornell Station (*B. 28, B. 32*) to the winter forcing of tomatoes, which, it is judged, may be carried on with profit, though it requires close attention. *B. 28* is devoted to this subject, and a full account is given with graphical illustration of the appliances and methods requisite to success. Some of the points made are that an abundance of sunlight is essential, a rich soil liberally fertilized is demanded, that winter tomatoes like a brisk bottom heat, that they must be trained, and that in midwinter the flowers must be pollinated by hand. Methods of obtaining a second crop are described, and some attention given to insects and diseases; but these subjects are more fully treated in *N. Y. Cornell B. 43.* In *Ohio B. 43*, while it is thought that with the prices obtainable in most parts of the West winter forcing will not pay, it is believed that the greenhouse can be used to good advantage in growing a tomato crop after the season for lettuce and other winter crops is over. The expense is comparatively light, and the demand for the house-grown tomatoes during strawberry and raspberry time has been surprising. Practical directions for carrying on such culture are given.

MANURING.—Experiments at the New York Cornell Station for two years (*B. 10, B. 21*) indicated that excessive manuring, contrary to a somewhat prevalent opinion, does not diminish but increases the yield; yet whether it pays on the whole is doubted. Experiments with fertilizers upon tomatoes have been rather frequent, especially comparing the effects of nitrate of soda, considered almost a

specific for this plant, with that of other applications. Trials are recorded in *Ark. R. 1890, p. 29; Del. B. 11; Ga. B. 11, B. 17; Md. B. 11, R. 1889, p. 43, R. 1891, p. 410; N. J. R. 1889, p. 102 (B. 63), R. 1890, p. 102, (B. 79), R. 1891, p. 85, B. O; N. Y. State R. 1891, p. 490; N. Y. Cornell B. 10, B. 21* (as above), *B. 32; Va. B. 11.* The New York Cornell Station (*B. 45*) thus sums up the results of experiments with nitrate of soda: "Upon fairly good soil, which contains some vegetable matter, nitrate of soda gives good results as a tomato fertilizer. We have formerly found that upon very poor soils it gives little or no benefit. It must be remembered, however, that nitrate of soda is an incomplete fertilizer and that it should not be relied upon for a permanent treatment of land. It is simply a source of nitrogen."

Tomato, bacterial blight [also called Southern tomato blight].—A disease which has been most injurious in the Gulf States, but has also been observed in New York (*N. Y. Cornell B. 45*). It may be recognized by the sudden wilting of the plant, especially the younger parts. The older leaves turn yellow and hang down the stem. Spots may be found upon the stem and leaves, resembling the water core of apples. In plants long affected, the green stem becomes brown and its lower leaves yellow and slimy. The attack may come at any time, either in the hotbed or in the field. Upon examination, the above-mentioned water cores will be found to be swarming with bacteria. As no trace of any other fungus is to be found, and innoculations spread the disease, it seems to be well established that the bacteria are the cause of the disease. A disease similar in every way attacks the potatoes in the same localities, and experiments tend to prove them identical.

The use of Bordeaux mixture is recommended as a preventive measure. All affected plants should be removed and burned. (*Miss. B. 19.*)

Tomato, leaf blight (*Cladosporium fulvum*).—A fungous disease which causes rusty brown patches to appear on the under side of the leaves. As these patches spread the leaf becomes yellow and wilted and finally falls from the plant. When the attack is severe it may kill the whole plant. As moisture is very necessary for this fungus, trimming and trellising will lessen the liability of attack. The use of Bordeaux mixture or carbonate of copper will hold the disease in check. (*Conn. State B. 111, R. 1890, p. 95.*)

Tomato rots.—The fungus *Phytophthora infestans* which produces potato rot also attacks the leaves, stems, and especially the green fruits of tomatoes. For treatment see *Potato rot.* A species of *Macrosporium* produces roundish decayed areas, becoming black, upon the fruit, and *Fusarium lycopersici* attacks the ripe fruit only, forming a thick mold over it, at first white, then reddish salmon-colored. Both these diseases may be held in check by removing any diseased fruit at once and by burning or burying it deeply to prevent the scattering of the spores. (*Conn. State R. 1890, p. 95.*)

Tomato worm (*Phlegethontius celeus*).—The larva of an insect greatly resembling the tobacco worm. For description and treatment see *Tobacco worm.* Several animal and fungous parasites tend to keep them from increasing rapidly. (*Conn. State R. 1890, p. 96; Ga. B. 6.*

Tree cricket (*Œcanthus niveus*) —A small, greenish-white, cricket-like insect that spends most of its time in trees. It is said to make a sound very much like the katydid. In the fall the females lay their eggs in holes made in raspberry or blackberry canes, by thrusting their long ovipositors more than half way through the canes. Ten to twenty eggs are thus laid in an irregular line of punctures; these punctures weaken the cane so as to cause it to split. The infested canes should be cut out and burned in the winter or early spring The young of this cricket feed largely upon plant lice, causing the destruction of great numbers of them. On this account it may not always be advisable to destroy them. They are said to infest grapevines, and the young twigs of fruit and other trees. There are numerous parasites attacking them and they are not liable to become dangerously numerous. There are

several other species besides the one given, but they are less common. (*Nebr. B. 14; N. Y. Cornell B. 23; N. Y. State B. 35; N. C. B. 78; Ohio R. 1888, p. 154, B. vol. II, 1.*)

Tuberculosis.—A specific infectious disease due to a minute parasite, *Bacillus tuberculosis.* Tuberculosis attacks man and most of the domestic animals. Cattle are especially liable. It is rare in the horse. It may be transmitted from the lower animals to men or from men to the lower animals. The tubercles which give the disease its name may be present in almost any part of the body, but especially in the lungs. These tubercles are at first globular masses about the size of millet seed. They increase in size, become yellowish, and may unite to form a collection of diseased matter even larger than an apple. If the disease affects the surface of an organ, the growth is hard and nodular. While there are many means through which the disease is transmitted, its spread is supposed to be due chiefly to the sputum and breath of diseased persons and animals. When dry, the germs float in the air and are inhaled and deposited in the lungs. Some systems are less resistant than others, and a slight inflammation of the mucous membrane and a depression of the system are among the causes predisposing to the disease. The danger is thought to increase with the number of germs, and hence ill-ventilated apartments, where the vitiated air is not sufficiently diluted, are favorable to the progress of tuberculosis.

In the early stages the symptoms are not always plain. A short dry cough is present, sometimes very noticeable after active exertion. The animal becomes poor, the coat rough, the eyes sunken. Sometimes tenderness and pain are evinced when the side of the chest is touched, and the normal sound of the lung becomes changed.

In cows, nymphomania frequently accompanies tuberculosis. When the udder is attacked the swelling there is painless and the milk at first is apparently normal.

Occasionally an animal rallies, but usually the progress is uniformly downward. Sometimes the course of the disease is quick, and again the decline extends through months or years. Medical treatment is useless. The tuberculous animals should be slaughtered and the stables thoroughly cleansed and disinfected.

A cold climate is believed to be less favorable to the distribution of tuberculosis than a warm one. The discoverer of *Bacillus tuberculosis* has shown that for development it requires a temperature between 86° and 104° F. Its period of incubation is about two weeks. Of more than five thousand cattle killed in the neighborhood of Baltimore, examinations showed that more than 3 per cent were affected with tuberculosis (*Pa. B. 21*).

Some animals inherit tuberculosis, but far more frequently it is acquired through the mother's milk, from human sputum, or from stabling with diseased animals. (*Me. R. 1890, p. 59*).

Experiments at the Pennsylvania Station (*B. 21*) confirm those made elsewhere in indicating that tuberculin, commonly known as "Koch's lymph," may be used by veterinarians as a sure means of determining whether cattle are affected with tuberculosis.

Investigations reported in *Mass. Hatch B. 8* tend to show that milk from tuberculous cows may contain the germs of the disease even when there is no lesion of the udder. There is a growing belief that tuberculosis is often transmitted to human beings through the milk of tuberculous cows. The importance of the subject demands that every precaution should be taken to keep milch cows free from this dread disease.

Turnip (*Brassica campestris*).—Varieties have been tested as recorded in *Ala. College B. 3, n. ser.; Colo. R. 1889, p. 103, R. 1891, p. 106; Md. R. 1889, p. 65; Mass. State R. 1888, p. 141; Minn. R. 1888, p. 262; Nebr. B. 12; N. Y. State R. 1882, p. 123, R. 1884, p. 197, R. 1885, p. 118; Ore. B. 4; Pa. R. 1890, p. 157; Vt. R. 1889, p. 142, R. 1890, p. 179.* In *N. Y State R. 1887, p. 168,* a classification of varieties is given, based upon form and color of root. Forty-one varieties are fully described, English and foreign synonyms given, and all names indexed. The Feltow turnip, a very small variety,

with a peculiar flavor in the outer rind, is described with the others (also in *N. Y. State R. 1882, p. 124,* where it is said to be recommended for pickling).

For composition see *Appendix, Tables I and II.*

The root system of a sample of turnip was examined at the New York State Station (*R. 1886, p. 160*) and found to be surprisingly small; this was thought to be accounted for by the small amount of nourishment stored up by the turnip and the abundance of moisture in the soil at the time when the turnip is growing. The deepest root did not extend beyond 18 inches, and the longest of the horizontal roots (which were few in number) reached no farther.

Experiments with fertilizers on turnips are reported in *Ala. College B. 3, n. ser.; N. J. R. 1891, p. 139.* A keeping test of varieties is recorded in *Ala. College B. 5, n. ser.*

Germination tests of turnip seed are reported in *Pa. B. 8; Vt. R. 1889, p. 110.*

Turnip, white rust, and downy mildew.—The fungi *Cystopus candidus* and *Peronospora parasitica* are frequently quite abundant upon turnips and may cause considerable loss. The best way to guard against these, or any other diseases of this crop, is to keep the fungi in check by carefully destroying all refuse left in the field. The crop might also be protected from attack by the use of any of the more common spraying compounds. (*Mass. State R. 1890, p. 222; N. J. R. 1890, p. 350.*)

Twig girdler (*Oncideres cingulatus*).—The adult insect attacks numerous trees, but seems to be worst upon pear trees. It is a brown or grayish-black beetle one-half to three-fourths inches long, with two long horns or "feelers." Across the back is a rather conspicuous gray band. In autumn the female lays her eggs beginning at the end of a twig and depositing an egg below each bud. She then girdles the twig between the eggs and trunk, cutting it so deeply that it usually falls from the tree. The object of this is to furnish dead wood for the larvæ, which are unable to develop in living wood. The eggs hatch and the larvæ undergo their transformation by spring to come forth as perfect insects. The only successful method of destroying them is to collect all fallen twigs and all girdled ones on the trees and burn them before the eggs hatch or the larvæ escape. The adults are very shy and nothing can be done with them. (*Fla. B. 9; Ga. B. 6; N. Mex. B. 2; N. C. B. 78.*)

Utah Station, Logan.—Organized in 1889 under act of Congress as a department of the Agricultural College of Utah. The staff consists of the president of the college and director, horticulturist and entomologist, chemist, consulting veterinarian, farm superintendent, and clerk and stenographer. The principal lines of work are field experiments with field crops, vegetables, and fruits, feeding experiments, and irrigation. Up to January 1, 1893, the station had published 2 annual reports and 19 bulletins. Revenue in 1892, $15,972.

Velvet grass.—*See Grasses.*

Verbena mildew (*Oidium erysiphiodes*).—A fungous disease which appears in white mold-like patches on the leaves and young shoots. It is especially bad on verbenas, but is liable to attack any house-grown plant. It may be kept in check by spraying the plants with a solution of potassium sulphide, one-fourth ounce to a gallon of water. This should be applied about twice a week. No doubt some of the copper compounds would be found equally effective. (*N. Y. Cornell B. 37.*)

Vermont Station, Burlington.—Organized under State authority December, 1886, and reorganized under act of Congress in 1888 as a department of the University of Vermont. The staff consists of the president of the college, director, chemist, botanist, entomologist, veterinarian, assistant chemist, superintendent of farm, dairyman, stenographer, and treasurer. The principal lines of work are chemistry, analysis and control of fertilizers, field experiments with fertilizers, field crops, vegetables and fruits, diseases of plants, feeding experiments, entomology, and dairying. Up to January 1, 1893, the station had published 5 annual reports and 30 bulletins. Revenue in 1892, $20,000.

Vernal grass.—See *Grasses.*

Vetch.—This name is properly used to designate leguminous forage plants of the genus *Vicia*, but is also applied to kindred plants of other genera. Common or spring vetch (*V. sativa*) is a slender twining plant which begins to grow late in the winter or early in the spring. In Michigan, the young plants are easily killed by frost (*Mich. B. 68*). In Nebraska it remained green till the beginning of winter and compared favorably with red clover (*Nebr. B. 6, B. 12*).

Vetch thrives best when sown with grain, by which the slender vines are supported. At the Connecticut Storrs Station (*B. 6*) 1 bushel of oats and 2 bushels of vetch per acre gave a yield of 8.6 tons of green forage. At the Oregon Station (*B. 4*), vetch gave a good yield of excellent forage.

See also *Ga. B. 7; Iowa B. 11; Me. R 1889, p. 167; Mass. State, R. 1889, p. 190, R. 1890, p. 172; Mich. B. 47; N. C. B. 73; S. C. R. 1888, p. 130.*

Russian or hairy vetch (*V. villosa*) is densely hairy. In Nebraska it proved very hardy, withstanding dry weather (*Nebr. B. 12*). At the Pennsylvania Station (*R. 1887, p. 139*) it produced a greater amount of dry matter than red clover. For analysis, see *Mass. State R. 1889, p. 180; Pa. R. 1887, p. 139.*

Winter vetch (*Lathyrus hirsutus,*) is sown early in the fall. By February, in Mississippi, the plants make a dense growth, and continue to grow till hot weather, Stock are fond of vetch, and the plant bears grazing well. "For the Gulf States, this is by far the most valuable of the many species which are sold under the general name of vetch, making a heavier growth, being eaten more freely, and reseeding itself more fully" (*Miss. B. 20*).

Lathyrus sativus proved a valuable early forage plant at the Mississippi Station (*R. 1889, pp. 21, 31*).

Chinese vetch (*Lathyrus* sp.) was also a success at the Mississippi Station (*R. 1889, p. 31*).

Violet diseases.—Few plants are subject to as many diseases as the cultivated violets. One of the worst is the anthracnose, *Glœosporium violæ.* This begins at the edge of the leaf and continues to spread until the whole plant is affected. A leaf-spot disease, *Cercospora violæ,* is conspicuous on account of the large, dead, ashy spots it produces on the leaves. Another spot disease is caused by *Phyllosticta violæ.* It may be distinguished by its straw-colored spots. A genuine mildew, *Peronospora violæ,* sometimes causes considerable loss. This does not produce any definite spots, but the whole affected plant withers and dies. There is a mold, *Zygodesmus albidus,* which produces upon the leaves patches white as flour, while its branching filaments are pushed everywhere through the leaf tissue. No doubt most or all these diseases could be prevented or controlled by the use of some of the common spraying solutions. There are two root diseases, one of which is caused by minute nematode worms forming root galls. The other causes the plant to turn yellow and die. Change of soil may prevent these diseases. (*Conn. State R. 1891, p. 161; N. J. R. 1890, p. 362.*)

Virginia Station, Blacksburg.—Organized under act of Congress May, 1888, as a department of the Virginia Agricultural and Mechanical College. The staff consists of the president of the college and director, vice-director, horticulturist, entomologist and mycologist, biologist, agriculturist, chemist, veterinarian, assistant horticulturist, assistant chemist, and treasurer. The principal lines of work are field experiments with fertilizers, field crops, fruits, and vegetables, and veterinary science and practice. Up to January 1, 1893, the station had published 2 annual reports and 23 bulletins. Revenue in 1892, $17,527.

Walnut trees (*Juglans* spp.).—The native black walnut (*J. nigra*) has received some notice as a forest and nut-bearing tree. A description from an economic point of view occurs in *Ala. College B. 3, n. ser.*, mentioning its well-known dark and fine-grained wood, the oil afforded by its nuts, and other useful products. It is rap-

idly disappearing and likely soon to be lost to the forests of the State without protection. Artificial plantations are recommended.

It is approved by the South Dakota Station (*B. 23*) for cultivation in the southern half of that State, though not expected to thrive as in the East. It has been planted as a nut or forest tree at the California Stations, as also a native species, *J. rupestris* (*R. 1888–'89, p. 196*).

The English walnut (*J. regia*), also known as Madeira nut, is being tested at the California, Michigan, and New Mexico Stations (*Cal. R. 1888–'89, pp. 87, 110, 137, 196, R. 1890, pp. 270, 280; Mich. B. 55, B. 67, B. 80; N. Mex. B. 4*)

The Japan walnut (*J. sieboldi*) has been planted at the Michigan South Haven Substation (*Mich. B. 67, B. 80*), and found to make a vigorous growth. The foliage and habit of growth indicated close relation with the butternut (*J. cinerea*).

For white walnut see *Butternut.*

Washington Station, Pullman.—Organized under act of Congress March 9, 1891, as a department of Washington Agricultural College and School of Science. The staff consists of the president of the college and director, agriculturist, horticulturist, forester and botanist, veterinarian, and chemist. The principal lines of work are field experiments with field crops, vegetables, and fruits, and forestry. Up to January 1, 1893, the station had published 1 annual report and 6 bulletins. Revenue in 1892, $15,000.

Water in feeding stuffs.—See *Feeding farm animals* and *Appendix, Table I.*

Water, warm vs. cold, for cows.—See *Cows.*

Watermelon (*Citrullus vulgaris*).—Variety tests of the watermelon are reported in *Ala. College B. 2, n. ser., B. 20, n. ser., B. 28, n. ser.; Colo. R. 1889, pp. 101, 121, R. 1890, pp. 192, 212; Fla. B. 14; Ky. B. 32; La. B. 27, B. 3, 2d ser.; Minn. R. 1888, pp. 251, 260; Nebr. B. 12; Nev. R. 1890, p. 17; N. Y. State R. 1885, p. 123, R. 1886, p. 238, R. 1887, p. 321, R. 1888, p. 127; Tenn. B. vol. V, 1; Utah B. 3.*

A thorough investigation of the watermelon with reference to its availability for the manufacture of sugar was undertaken at the California Station, as reported in *R. 1878–'79.* A physical analysis showing proportions of seeds, pulp, and rind, proximate chemical analyses of these components, and a sugar analysis of the juices are given. The cane sugar was found to average only about 2.66 per cent by weight of the juice, far too little to make the watermelon a profitable source of sugar. It was thought, however, that a bright and palatable sirup, not liable to granulation, might be advantageously produced; but on experiment it was found that the sirup, whether purified by skimming or defecated with lime, turned so dark-colored that it could hardly be acceptable in the market.

Some notes on the extent and method of watermelon culture may be found in *Fla. B. 14; Tenn. B. vol. V, 1.*

At the Alabama College Station (*B. 28, n. ser.*) the experiment was tried of planting separately seeds from the stem end, the middle, and the blossom end. The seed from the middle third gave earlier and larger fruit and more by weight per acre. The seed in the middle ripen earlier, but it was thought that if the seed melon had been left till all the seeds had matured the difference might have been less marked.

In experiments in herbaceous grafting at the New York Cornell Station (*B. 25*) muskmelon vines were found to unite with watermelon, these and cucumbers with the wild cucumber (*Echinocystis lobata*). In the same bulletin are reported observations on the watermelon and other cucurbits, showing that the staminate flowers are earlier and much more numerous than the pistillate.

Germination tests of watermelon seed are reported in *Ohio R. 1884, p. 196, R. 1885, p. 177; Ore. B. 2; Vt. R. 1889, p. 106.* Tests of the seed of the citron melon are recorded in *Ohio R. 1884, p. 196, R. 1885, p. 168.*

Wattle trees.—See *Acacia trees.*

Webworm, fall (*Hyphantria cunea*).—An insect very destructive to many shade

and fruit trees, especially the ash, walnut, butternut, elm, hickory, willow, apple, pear, and cherry.

The full grown worm is usually about an inch long, and covered with whitish hairs. Its general color is yellowish green, with black along the back and spots of black along the sides; under sides usually brown; head and legs black. The worms may be confounded with tent caterpillars, but the fact that the webworm feeds *within* its web, enlarging it as more food is needed, and the tent caterpillar feeds *without* its web, easily distinguishes them. The moth is about an inch across the wings, white or spotted on the forewings. The eggs are laid upon the leaves in May or June. This is for the first brood, and the average number of eggs is 500.

They soon hatch and the caterpillars spin a web, enlarging it as necessity demands until they are mature, which is in about a month. They then desert the web and seek the ground, where they become transformed into perfect insects. The second brood appears in August and September, and on account of their greater numbers prove the more destructive. The fall webworms have many natural enemies, which ordinarily keep them in check. When abundant and destructive, burning the nests or spraying arsenites about them will kill the worms. In the extreme north but one brood a year is to be expected during an ordinary season. (*Ky. B. 40; Me. R. 1890, p. 124; Minn. B. 9; Nebr. B. 14; N. J. R. 1889, p. 303; N. Y. State B. 35; S. C. R. 1888, p. 29; Vt. R. 1889, p. 153.*)

Webworm, garden (*Eurycreon rantalis*).—The larvæ feed on almost any plant, over which they spin their web and then eat off the leaves. The moth is about three-fourths of an inch across the wings. The general color is orange or reddish-yellow, commonly shaded with gray, with varying wing markings. The larvæ are variable in color, being either light or dark yellow or yellowish green, with rather distinct black spots The number of broods is not known, but four or five are thought to be produced each season. It has numerous enemies, which keep it in check to a limited degree. Spraying with Paris green, one pound to 100 gallons of water, will kill these insects. They are not yet known east of the Missouri River. (*Colo. B. 6; Nebr. B. 16.*)

Weeds.—The description, frequency, troublesomeness, and eradication of weeds have been considered in about forty reports and bulletins issued from a score or more of the stations. Quite a number of lists of "worst weeds" have been prepared for various States and localities. Of our worst pests it is known that at least five-sixths are of European origin. These have either escaped from gardens or have been imported in foreign seed or in packing and ballast.

The importance of keeping down the weeds is too often unrecognized. The cost in additional labor to cultivate the crop, the robbing of the crops of those substances which should go to their own growth and development, the depreciation of the market value of the crop itself, due either to the presence of weeds or weed seeds, has been estimated in one State to be at least $1 annually for every acre of cultivated land.

In general the means recommended for combating the attack of weed pests are sowing of absolutely clean seed, thorough and clean cultivation, the rotation of crops, and the destruction of weeds before they go to seed.

This article contains descriptions of a number of the weeds which are most widely troublesome or which are likely to become so, together with a list of plants which are described in station publications as weeds in different localities.

Blue thistle or bugloss (*Echium vulgare*).—A native of Europe and Asia, well established throughout the Middle Atlantic States, from which it is spreading with considerable rapidity. It is a biennial plant 2 to 3 feet high, rough, hairy, and rather leafy. The leaves are rather long and narrow, strap-like, the lower from 5 to 8 inches long, the upper decreasing above, until they become shorter than the flower clusters. Like the stem, the leaves are covered with stiff, white hairs having a stinging property. The upper part of the stem bears numerous clusters of flowers

for half its length or more. These clusters, or racemes, as they are called, are coiled down while in bud, but are straightened out in flower. The flowers are crowded, five parted, with a purplish color, fading to light blue, about an inch long. The nutlets are four to each flower, of peculiar shape, and are said to resemble in appearance a viper's head. Where the plants are few they should be pulled up before going to seed; if more numerous, deep fallow plowing, with subsequent careful cultivation, will serve to destroy them.

BROOM RAPE (*Orobanche ramosa*).—A recent importation from Europe, which threatens serious injury to our tobacco and hemp fields. It was first reported in Kentucky five or six years ago and since then has spread to some of the adjoining States. It seems to find more favorable conditions for its growth here than in Europe, as it is a much larger and more robust plant with us. It is an annual, 6 to 15 inches high, with many slender branches of a brownish or straw color, more or less hairy, and is found parasitic on the roots of tobacco and hemp. Its leaves are represented by small, colorless bracts. The flowers are scattered along the slender branches and have very short flower stalks. There are three small bracts to each flower, one, the largest, at the base of the flower stalk, the other two just under the flower. The calyx of the flower is four-toothed and split down the back; the corolla, which is said to be light blue, is two-lipped, the upper lip notched and the lower three lobed. The seeds are minute and very numerous. The habit of this plant is something like the clover dodder. It fastens itself to the roots of tobacco or hemp and sucks from them its nourishment and eventually kills the host it lives upon.

Such plants as these are especially to be dreaded and nothing should be left undone to exterminate them. The use of clean seed is very important.

BURDOCK (*Arctium lappa*).—A well-known weed, which grows extensively throughout the United States, and is dreaded more on account of its burs than because of its injury to crops. It is a tall, coarse biennial weed belonging to the family of plants known as *Compositæ*. The stem is from 2 to 5 or more feet high, considerably branched, and bearing at the top clusters of flowers. These are of a bluish color in the head, surrounded by an involucre, the scales of which are hooked. These form the bur, which fastens itself into the wool or hair of animals, causing them great annoyance. The leaves are from a few inches to a foot or more long, heart-shaped at base, and often toothed along the margin. The burdock prefers a rich soil and is not very hard to eradicate. Frequent cutting below the crown of the root will soon kill it out. Keeping it from seeding for two seasons will also destroy it. Mowing while in flower is not a sure method of repression.

BUR GRASS (*Cenchrus tribuloides*).—A native annual grass, which is much too common in the South and Southwest in warm sandy soil and is extending its way to the North. It is said to take possession of vast areas of the Great Plains after the period of cultivation is past. It has a stem, spreading and branching at the base, from a few inches to 3 feet high. The leaves are three to ten on the stem, sometimes hairy, but usually smooth, with a blade about 6 inches long and a quarter of an inch wide. The flowers are borne in bur-like clusters in a rather compact spike. Each bur incloses two or three flowers and the ripened seed. The burs are armed with stiff, sharp, barbed spines, which easily penetrate the flesh and are painfully irritating to man and stock. Thorough cultivation until too late in the season for it to mature seed or choking it out with some earlier or more rapid-growing grass will aid its destruction.

CANADA THISTLE (*Cnicus arvensis*).—A native of Europe, probably introduced into this country through Canada. It grows 2 or 3 feet high, the stems greatly branching and very leafy. The leaves are from 3 to 6 inches long and an inch or more wide, somewhat lobed, and bear along their margins numerous sharp stiff prickles a quarter of an inch or more in length. The flowers are clustered more or less at the ends of the branches, and are rather less than an inch long. The flower is covered externally with a close scaly involucre, the scales of which are not prickly-pointed. The

plants are of two kinds, male and female, and to this fact is due the frequent failure to seed, the whole patch being of one sex.

In addition to propagation by seed it increases largely by means of underground runners. These reach deep and far from the parent plant and are furnished with buds from which may spring new plants. The Canada thistle seems to prefer rather dry land, but will grow equally well in low and damp places, especially in heavy soil. Occasional plowing or hoeing will serve rather to increase than diminish this pest, as in that way the runners are detached and scattered, hastening its spread. Frequent plowing during the hot summer months and care to prevent seeding will usually serve to eradicate this weed.

CHEAT OR CHESS (*Bromus secalinus*).—A well-known weed in wheat fields, especially in wet seasons. Some persons still believe that it is a degenerate form of wheat, but this theory has no foundation in fact.

The plant is an annual or at most a biennial, but the seed can lie dormant in the ground for several seasons awaiting proper conditions for its growth. It will yield to high cultivation, liberal application of fertilizers, and the use of clean seed. If it has been permitted to seed in a field, wheat or small grain should not be sowed in that field the following year, but rather a cultivated crop of some kind.

CORN COCKLE OR COCKLE (*Lychnia githago*).—A weed introduced into our grain fields in foreign wheat and rye, which in some localities has become a great nuisance. In some markets grain dealers are compelled to reduce the grade of wheat having cockle in it, as it lowers the grade of flour. Cockle can hardly be screened out of wheat, hence the importance of keeping it from the fields. It is an annual plant, of the pink family, having large showy flowers of a reddish purple color. The plant is or 3 feet high, branched above. The leaves are narrow, opposite, and tapering to a point. Both leaves and stem are covered with soft white hairs. The calyx of the flower is ten ribbed, and is divided into five narrow lobes which are longer than the inch-and-a-half long purplish corolla. The fruit is a dry oblong pod filled with dark-colored seeds, which under a lens are seen to be strongly ribbed and roughened. About the only way to get rid of this harmful weed is to sow clean seed.

COCKLEBUR (*Xanthium canadense, X. strumarium*).—There are three species of cocklebur in the United States, one native and two introduced. For our purpose we shall consider only the native species; the others resemble this very closely.

The cocklebur is a coarse branching annual plant usually 1 to 3 feet high, with alternate rough, three-veined, somewhat lobed leaves, heart shaped at base on rather long leafstalks. The stem is often more or less brown or purplish spotted. The flowers are of two kinds, the male flowers in globular heads, the female flowers below at the base of the leafstalks either singly or in clusters. After shedding their pollen the male flowers dry up and disappear and the female heads enlarge, becoming oblong burs about an inch in length, beset with stiff hooked prickles. The burs are two-celled, each cell containing a single seed. Like burdock, this plant is more troublesome to animals than to crops. Being an annual it can be exterminated by preventing its seeding. The seeds have remarkable vitality and will grow after having been hidden in the ground for a long time. The waste places must be looked after if this weed is to be eradicated, for it will spread far and wide from these places.

CURLED OR YELLOW DOCK (*Rumex crispus*).—This weed, of European origin, is now scattered entirely across our continent and in some places it is quite a pest. It is closely related to the horse sorrel. It is a smooth plant growing 3 or 4 feet high with lance-shaped leaves, having strongly curled or wavy margins. Some of the leaves, especially the lower ones, have heart-shaped bases. The flowers and fruit are borne above in whorls around the stem. When mature, the seed is inclosed in a valve or scale, which is rather prominently marked with veins, and has a heart-shaped base. The pedicels on which the fruit stand are rather slender and may be bent downward on the stem. The heart-shaped base of the fruiting valves and the curled margin of the leaves should distinguish this from any other of our common

docks. Its roots are large and sink deep into the ground, making it very difficult to pull up. It seems to prefer meadows, gardens, and yards, from which it may be removed by frequent grubbing out and preventing the formation of seed.

DODDER.—The clover dodder (*Cuscuta trifolii*), a rather recent importation from Europe, is fast becoming one of the worst pests of our clover fields. It is a parasitic plant in its habits, without any leaves, or with mere useless scales in their place. It first sends up a yellowish wiry stem and twining about the clover derives its nourishment by means of sucking disks, which it forces into the clover stem. The lower part of the dodder plant soon dies, but the upper part goes on growing and spreading its yellow threads in all directions. The clover, losing the sap intended for its own support, soon turns brown, dies, and rots. In this way large patches of clover may be wholly destroyed in a single season. The flowers of the dodder are borne in small clusters and are about the same color as the rest of the plant. It is easily recognized by its peculiar yellow threads twining everywhere.

A similar species (*Cuscuta epilinum*) is called the flax dodder from its attacking flax in the same manner as the other species does the clover.

The remedy in both cases is to use only clean seed. The seed of dodder is smaller than clover seed and could be screened out. Where it has gained a hold, it should be mowed and burned so as to prevent seeding. Under no circumstances should seed be used from a field known to be infested.

FOXTAIL GRASS (*Setaria glauca*).—A well known grass infesting gardens, stubble fields, corn fields, and almost every cultivated place. It is in some repute as a forage grass, but is of rather doubtful usefulness, especially after the heads appear and the long awns are developed. It is an annual grass derived from Europe, growing a foot or two high. The leaves are rather abundant, long, and flat. The spike or "head" is cylindrical, 2 to 4 inches long, compact, and tawny-yellow. The bristles are in clusters of from six to ten, barbed upwards, rigid and much longer than the spikes. It is perhaps due to these awns that cattle will not eat the grass, for they would penetrate their mouths and stomachs, causing great pain. When once established, thorough cultivation and the sowing of clover or some early-growing grass will usually choke it out. Its growth is rapid, hence its abundance in stubble fields and corn fields after cultivation has ceased. Another species (*Setaria viridis*) is similar in appearance and habits of growth.

GARLIC OR WILD ONION (*Allium vineale*).—A vile weed, especially troublesome in moist meadows and fields. It is especially abundant in the eastern portion of the country, but is making its way toward the South and West. Its stems are slender, from 1 to 3 feet high, with the sheathing bases of the leaves clothing it below the middle. The leaves are round, hollow, and somewhat grooved toward the top. At the end of the stem is borne a dense cluster of bulbs usually called "sets." When abundant in wheat fields these sets are said to get in with the grain and to spoil the flour.

This weed when eaten by cows imparts a strong flavor to butter and milk. Nothing but a series of cultivated crops seems to have any effect upon the spreading of the weed where it has secured a start.

HORSE-NETTLE OR SAND BRIAR (*Solanum carolinense*).—A thorny weed, native in the Southern and Southwestern States from which it is rapidly spreading. It seems to prefer a light sandy soil, but it will thrive in almost any soil when once established. It is a low perennial plant with deep running roots. The stems are a foot or more high, rather straggling, branching, and somewhat shrubby at base. The stem and midvein of leaves beneath are beset with sharp, stout yellow prickles, which make it very formidable. The stem and leaves are clothed with minute star-shaped hairs having from four to eight or more points. The leaves are rather large for the plant, oblong, short stalked, and often more or less lobed or cut. The flowers are usually borne above in clusters of from three to ten, each on a short stalk of its own. The flowers are blue or bluish-white, about an inch in diameter, and some-

what star-shaped with five lobes. They are succeeded by greenish-yellow globular berries filled with numerous seeds. The plant is closely related to the potato, having flowers and berries almost identical with those of that plant.

This weed is so tenacious of life that it is exterminated with great difficulty. When it appears it should at once be destroyed, or in time it will grow in such thick patches as to monopolize the soil.

Indian mallow or Velvet leaf (*Abutilon avicennæ*).—A native of Asia, first introduced as an ornamental plant. It is a coarse annual plant attaining a height of 5 feet or more. The stem and leaves are covered with short soft hairs which give it the name of velvet leaf. The leaves are round, heart-shaped, 3 to 6 or more inches long. The stalk of the leaf is shorter than the blade, in which there are about five prominent veins diverging from the base. In the angle between leaf-stalk and stem is produced the flower stalk which bears from one to five or more yellowish flowers about three-fourths of an inch in diameter. The calyx of the flower is five parted and green in color. The corolla is five parted, and orange yellow in color. In the center are numerous stamens surrounding the twelve or more styles. The fruit when mature is rather bell-shaped and about an inch in diameter. It is an aggregation of numerous pods each of which is surmounted by two divergent horns. In some places this plant is called stamp weed or butter print from the use of the fruits in stamping ornaments on butter. Being an annual, care taken not to let it go to seed will result in its extermination.

Jamestown weed, Jimson or Thorn apple (*Datura stramonium*).—A coarse weed which, with its allied species (*Datura tatula*), is of considerable importance on account of its poisonous properties when eaten. The plant is an annual and varies greatly in size. The stem is green, leaves large and angularly cut, the flowers about 3 inches long, white, funnel shaped, with a border of five lobes or teeth. The other species (*D. tatula*) has red stems and pale violet purple flowers. The seed pods are rather egg shaped and very thorny, hence the name thorn apple. The seeds are flat, black, and very poisonous. As it is an annual and grows only in rich soil its destruction may be secured by preventing its maturing seed.

Lamb's-quarters or Pigweed (*Chenopodium album*).—This, with some of its allied species, is one of the vilest and most unsightly weeds, and is found almost everywhere in the United States. The plant varies greatly in its growth, being sometimes less than a foot high and at others 5 or 6 feet. The stem is rather stout, angled, and much branched. The leaves are very variable, some being long and narrow, others broad and more or less lobed or toothed. The whole plant is more or less covered with a white mealy powder. The flowers are insignificant and are clustered in small, round bunches along a long spike which terminates the branches. The mature seed is round in outline, flattened like a lens, smooth, shining, black, and rather closely covered with a thin green scale-like coating. It infests neglected cultivated land, and should be kept from seeding.

May weed or Dog fennel (*Anthemis cotula*).—A weed, known in different localities under different names, well naturalized throughout a large portion of our country. It is closely related to the oxeye daisy, and, like all plants of that family, is plentifully provided with seed. It is an annual, growing a foot or more high. Its leaves are rather numerous and are dissected into many very narrow divisions. Its flowers are somewhat like those of the daisy, but smaller, having a yellow center of numerous minute flowers and a border of white, flat, ray flowers which in age droop back toward the stem. The plant has a very strong and disagreeable odor, by which it may easily be recognized. It frequents roadsides, pastures, and other rather dry situations, from which it can be exterminated by preventing its seeding. It will not grow where thick grass is found and it may be overcome by seeding to some kind of grass in fields where it has become a nuisance.

Oxeye daisy (*Chrysanthemum leucanthemum*).—Perhaps the worst weed of the eastern part of this country and making rapid progress towards the West and South.

It is a foreign plant which is thought to have spread from flower gardens. It is a perennial closely related to the mayweed or dog fennel, but very much more to be dreaded and harder to get rid of than its relative. It somewhat resembles the mayweed, but is a l rger and coarser plant. It grows a foot or two high with usually few branches, but often several stems from one root. The leaves are not very abundant. They are coarsely toothed, rather long and narrow, the upper attached directly to the stem, the lower having a leaf stock of varying length. The base of the upper leaves clasps the stem with a fringed border. The main stem and a few branches are terminated by single heads of flowers, which, when expanded, often are an inch and a half in diameter. The center is made up of hundreds of small yellow flowers, which are surrounded by a circle of flat, white rays, as they are called. This weed is especially troublesome in meadows and pastures, some of which are completely covered with the white flowers of this pest. Like the Canada thistle, this weed propagates by seeds and underground runners, and it is only with the greatest care that it can be conquered Close pasturing by sheep is said to kill it, but clean cultivation for several years where it has secured a hold is the only certain means of its extermination. Even then great care must be taken not to let any go to seed, for the light seeds are scattered far and wide by the wind.

PURSLANE OR PURSLEY (*Portulaca oleracea*).—A very troublesome weed in gardens and highly cultivated places. Its capacity for seeding is enormous, and as the seeds are matured in a few days after flowering constant watch must be kept over it. It has been estimated that an ordinary plant in the course of a season will produce two million seeds, each of which will grow if room enough can be found. It is an annual, with a thick, prostrate stem and fleshy, wedge-shaped leaves. The flowers are yellow and open mostly upon bright sunny mornings. The seed pod is one celled and filled with seeds, which escape from the top of the pod. It may be kept down in the garden by constant use of the hoe, but when it gets bad in fields it can only be subdued by sowing grass and letting it stand for several years.

RAG WEED (*Ambrosia artemisiæfolia*).—A native weed growing throughout the country Where it becomes established it is hard to eradicate, as it often seeds when but a few inches above the ground. It is an annual of the order of *Compositæ*. It attains a height of 3 or more feet, is rather slender, and much branched. The leaves are from 1 to 4 inches long, mostly alternate and rather thin, cut into narrow lobes, which are often lobed or toothed again. The flowers are of two kinds, borne on a slender spike. The male flowers are at the end of the spike in little clusters of five to eight, inclosed in a green cup-like involucre. Each cluster is borne on a short nodding stalk. The female flowers are clustered at the base of the spike and when mature resemble small hard nutlets. Being an annual it must be kept from seeding to exterminate it. Close cultivation will serve to keep this pest down, but the roadsides and places along the fences must be looked after.

RIB GRASS, ENGLISH OR BLACK PLANTAIN (*Plantago lanceolata*).—A weed probably imported in clover seed. It is a perennial, having a short thick root stock. The leaves are all from the base, long stalked, blade lance shaped, tapering to each end, three to seven ribbed, more or less toothed along the margin, and usually rather hairy, although sometimes perfectly smooth. The leaves vary from 3 to 6 inches in length, sometimes becoming nearly 2 feet long, but seldom much exceeding an inch in width. Its flower stalk comes up from the roots and bears a compact spike of flowers at the summit, which varies from but a few of the small sessile flowers to a spike at least 2 inches long. The seeds, which are two to every flower, may be recognized by their being hollowed out on one side, thus distinguishing them from clover or grass seeds. Its leaves, when not too crowded, lie rather flat, thus choking out any grass near it. Great care should be exercised in choosing grass or clover seed that it does not include the seed of this plant. Where once established the meadow or pasture should be thoroughly cultivated for a year or two. In this way it, as well as the other plantains, may be eradicated.

SHEPHERD'S PURSE (*Capsella bursa-pastoris*).—A very common weed, especially annoying in gardens. It begins flowering and fruiting when but an inch or two high, and keeps this up until it attains a height of 18 inches or more. Most of the leaves are near the ground, where they are 5 or 6 inches long, cut and toothed very much like the dandelion leaf. The upper stem leaves decrease in size, are arrow shaped, and have no leafstalk. The flowers are very small and at first clustered together, but as the plant grows they stretch apart on quite a long axis, to which each flower is attached by a slender stalk a half inch or so long. The pod is about a quarter of an inch long, flat, broad at the top, where it is notched, and tapering toward the base, somewhat resembling an old-fashioned purse. Although so common and abundant it will usually yield to careful cultivation.

HORSE SORREL or RED SORREL (*Rumex acetosella*).—A native of Europe, found growing on worn or thin soil, where it spreads rapidly by means of underground runners. It frequently takes possession of richer soils, crowding out better plants, especially during a long, dry season. The plant belongs to the family furnishing us buckwheat, the docks, and smart weeds, all of which may be recognized by their usually three-angled seeds. The stems are seldom much over a foot high, slender, and somewhat furrowed. The leaves are rather scattered on the stem. The lower ones have long leafstalks, which decrease in length until the upper ones are attached by the leaf blade to the stem. They are usually arrow shaped, having more or less prominent lobes at the base, which spread at right angles to the midrib. The flowers are of two kinds, male and female on different plants, scattered in bunches of three to six or more along the upper part of the stem. The female flowers are said to be a little larger than the male flowers, but both kinds are small and unattractive.

This pest may usually be eradicated by enriching the soil and by clean cultivation for a season or two.

TOAD FLAX, BUTTER AND EGGS, or RAMSTED (*Linaria vulgaris*).—A weed which is rapidly spreading in this country and which should be rigidly dealt with, for having once secured a hold it is very tenacious of life. It is a perennial and sends out many underground runners, which aid in its rapid spread and at the same time make it more difficult to eradicate, for every piece seems able to reproduce a new plant when separated from the parent. It grows a foot or two high and has narrow light-green leaves. The whole plant is very smooth. The flowers are light yellow, of very irregular shape, like those of the snapdragon, about an inch long, and each with a downwardly projected spur of about the same length. They are in rather compact clusters, 2 to 8 inches in length at the end of branches and stems. In mass it is a rather pretty sight, and its habit of growing along roadsides in dry soil has often been the means of its spread to adjoining fields through neglect of the waste places. Only careful and persistent cultivation will rid a field of this weed when once well established.

WILD CARROT (*Daucus carota*).—A native of Europe, but now thoroughly established in most parts of this country. In several lists of "worst weeds" this is given a prominent place in the first rank. The first year of its growth there is only a dense rosette of leaves near the ground, but the second year it sends up a stout stem, bears fruit, and dies. It spreads rapidly by means of its numerous seeds, one investigator having counted over fifty thousand on a plant of average size. The plant is rather bristly, 2 feet or more high, branched, and the branches terminated by a flat or cup-shaped cluster of flowers, which in turn are replaced by the fruit. This is provided with numerous bristly hooks, by which the seed may attach itself to any passing object and secure transportation and extension of range. The leaves are all finely cut into numerous divisions and the flowers are white. The life of this plant being confined to two years it may be exterminated by preventing its going to seed for that length of time, provided, of course, no new seed is introduced.

Information regarding the weeds in the following list has been given in the station publications to which reference is made under each species. In a number of cases the same botanical species is designated by several common names.

List of weeds in the United States, with references to station publications.

Common name.	Scientific name.	Station publications.
Alkali grass	*Distichlis maritima*	Cal. R. 1890.
American jute	*Abutilon avicennæ*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Angelica tree	*Aralia spinosa*	W. Va. B. 23.
Apple of Peru	*Nicandra physaloides*	W. Va. B. 23.
Balm	*Monarda fistulosa*	W. Va. B. 23.
Barnyard grass	*Panicum crus-galli*	Fla. B. 8; N. J. R. 1890.
Basil	*Calamintha clinopodium*	W. Va. B. 23.
Bastard jasmine	*Lycium vulgare*	N. J. R. 1890.
Bastard pennyroyal	*Trichostemma dichotomum*	N. J. R. 1890.
Beaked horsenettle	*Solanum rostratum*	Iowa B. 13; N. J. R. 1890.
Beard-grass	*Heteropogon melanocarpus*	Fla. B. 8.
Beard-tongue	*Pentstemon lævigatus*	N. Y. Cornell B. 37.
Bear-grass	*Cenchrus tribuloides*	Fla. B. 8; N. J. R. 1890.
Bear-grass	*Yucca filamentosa*	Fla. B. 8.
Beautiful wild lettuce	*Lactuca pulchella*	N. J. R. 1890.
Beaver poison	*Cicuta maculata*	W. Va. B. 23.
Beggar's lice	*Bidens connata*	N. J. R. 1890; W. Va. B. 22.
Beggar's lice	*Bidens frondosa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Beggar's lice	*Lappula virginica*	W. Va. B. 23.
Beggar-ticks	*Bidens frondosa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Beggar-ticks	*Bidens lævis*	N. J. R. 1890.
Bermuda grass	*Cynodon dactylon*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Biennial wormwood	*Artemisia biennis*	N. J. R. 1890.
Big root	*Megarrhiza* species	Cal. R. 1890.
Bindweed	*Convolvulus arvensis*	Cal. R. 1890; N. J. R. 1890; Wis. B. 20.
Bindweed	*Ipomœa tamnifolia*	Fla. B. 8.
Bird's-nest thistle	*Cnicus horridulus*	Fla. B. 8.
Bitter dock	*Rumex obtusifolius*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Bittersweet	*Solanum dulcamara*	N. J. R. 1890; W. Va. B. 23.
Bitterweed	*Ambrosia artemisiæfolia*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Black bindweed	*Polygonum convolvulus*	Fla. B. 8; Me. R. 1889, pt. III; N. J. R. 1890; Wis. B. 20.
Black-cap	*Rubus occidentalis*	N. J. R. 1890.
Black cohosh	*Cimicifuga racemosa*	W. Va. B. 23.
Black locust	*Robinia pseudacacia*	W. Va. B. 23.
Black medick	*Medicago lupulina*	N. J. R. 1890.
Black mustard	*Brassica nigra*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Black-root	*Pterocaulon pycnostachyum*	Fla. B. 8.
Black snakeroot	*Cimicifuga racemosa*	W. Va. B. 23.
Bladder bean	*Glottidium floridanum*	Fla. B. 8.
Bladder campion	*Silene inflata*	N. J. R. 1890.
Bladder ketmia	*Hibiscus trionum*	N. J. R. 1890; W. Va. B. 23.
Bladder leaf	*Utricularia subulata*	Fla. B. 8.
Blanket grass	*Panicum serotinum*	Fla. B. 8.
Blessed thistle	*Carduus benedictus*	Cal. R. 1890.
Blue boneset	*Eupatorium cœlestinum*	W. Va. B. 23.
Blue curls	*Brunella vulgaris*	N. J. 1890; W. Va. B. 23.
Blue curls	*Trichostema lanceolatum*	Cal. R. 1890.
Blue devil	*Aster cordifolius*	N. J. R. 1890; W. Va. B. 22, B. 23.
Blue lettuce	*Lactuca ceucophæa*	N. J. R. 1890.
Blue lobelia	*Lobelia syphilitica*	N. J. R. 1890.
Blue thistle	*Echium vulgare*	N. J. R. 1890; W. Va. B. 22, B. 23.
Bluets	*Houstonia cœrulea*	W. Va. B. 23.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Blue vervain	*Verbena hastata*	N. J. B. 1890; W. Va. B. 23.
Blue violet	*Viola cucullata*	N. J. R. 1890.
Blue weed	*Echium vulgare*	N. J. R. 1890; W. Va. B. 22, B. 23.
Boar thistle	*Unicus lanceolatus*	Fla. B. 8; Iowa B. 13; N. J. R. 1890; W. Va. B. 22, B. 23.
Bokhara clover	*Melilotus alba*	N. J. R. 1890; W. Va. B. 23.
Boneset	*Eupatorum perfoliatum*	N. J. R. 1890.
Bottle grass	*Setaria viridis*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Bouncing bet	*Saponaria officinalis*	N. J. R. 1890; W. Va. B. 23.
Box thorn	*Lycium vulgare*	N. J. R. 1890.
Brachen fern	*Pteris aquilina*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Bracted bindweed	*Convolvulus sepium*	N. J. R. 1890.
Brake fern	*Pteris aquilina*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Bramble	*Rubus strigosus*	N. J. R. 1890.
Branched pigweed	*Amarantus paniculatus*	N. J. R. 1890.
Briars	*Rubus* species	Fla. B. 8; N. J. R. 1890; W Va. B. 22, B. 23.
Bristly galingale	*Cyperus strigosus*	Fla. B. 8; N. J. R. 1890.
Broad-leaved dock	*Rumex obtusifolius*	Cal. R. 1890: N. J. R. 1890; W. Va. B. 22 B. 23.
Broom brush	*Hypericum proliferum*	W. Va. B. 23.
Broom grass	*Heteropogon acuminatus*	Fla. B. 8.
Broom rape	*Orobanche ramosa* (*Phelipæa ramosa*).	Ky. B. 24.
Broom sedge	*Andropogon scoparius*	Fla. B. 8; N. C. B. 70; W. Va. B. 22, B. 23.
Brown-eyed Susan	*Rudbeckia* species	N. J. R. 1890; W. Va. B. 22, B. 23.
Buck-horn or Buck plantain.	*Plantago lanceolata*	Cal. R. 1890; Iowa B. 13; Me. R. 1889, pt. III, R. 1890; Mich. B. 56, B. 72; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Buckwheat	*Fagopyrum esculentum*	N. J. R. 1890.
Buffalo clover	*Trifolium reflexum*	Fla. B. 8.
Bulbous buttercup	*Ranunculus bulbosus*	N. J. R. 1890.
Bull grass	*Elusine indica*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Bull nettle	*Solanum carolinense*	Fla. B. 8; Iowa B. 13; N. J. R. 1890; W. Va. B. 22, B. 23.
Bull's eye	*Chrysanthemum leucanthemum.*	Cal. R. 1890; Iowa B. 13; N. J. R. 1890; N. C. B. 70; Wis. B. 20; W. Va. B. 22, B. 23.
Bull's thistle	*Cnicus lanceolatus*	Fla. B. 8; Iowa B. 13; N. J. R. 1890; W. Va. B. 22, B. 23.
Bulrush	*Scirpus stenophyllus*	Fla. B. 8.
Bur clover	*Medicago denticulata*	Cal. R. 1890.
Burdock	*Arctium lappa*	N. J. R. 1890; W. Va. B. 22, B. 23; Wis. B. 20.
Bur grass	*Cenchrus tribuloides*	Fla. B. 8; N. J. R. 1890.
Bur marigold	*Bidens cernua*	N. J. R. 1890.
Bur marigold	*Bidens frondosa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Bur marigold	*Bidens lævis*	N. J. R. 1890.
Bush clover	*Lespedeza frutescens*	N. J. R. 1890.
Butter-and-eggs	*Linaria vulgaris*	Mich. B. 72; N. J. R. 1890; W. Va. B. 22; Wis. B. 20.
Butterfly weed	*Asclepias tuberosa*	N. J. R. 1890; W. Va. B. 23.
Butter print	*Abutilon avicennæ*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Butterweed	*Erigeron canadensis*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Buttonweed	*Diodia teres*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890.
California lily	*Calochortus invenustus*	Cal. R. 1890.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
California poppy	*Eschscholtzia californica*	Cal. R. 1890.
California tarweed	*Hemizonia elegans*	Cal. R. 1890.
California tarweed	*Madia sativa*	Cal. R. 1890.
Camphor weed	*Trichostema lanceolatum*	Cal. R. 1890.
Canada golden-rod	*Solidago canadensis*	N. J. R. 1890.
Canada hawkweed	*Hieracium canadense*	N. J. R. 1890.
Canada thistle	*Cnicus arvensis*	Cal. R. 1890; Ill. B. 12; Iowa B. 13; N. J. R. 1890; W. Va. B. 22, B. 23; Wis. B. 20.
Canaigre	*Rumex hymenosepalus*	Cal. R. 1890.
Careless weed	*Amarantus spinosus*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Carpet weed	*Mollugo verticillata*	Cal. R. 1890; Fla. B. 8.
Carrot	*Daucus carota*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Cat briar	*Smilax rotundifolia*	N. J. R. 1890.
Catnip	*Nepeta cataria*	N. J. R. 1890; W. Va. B. 23.
Celandine	*Chelidonium majus*	N. J. R. 1890.
Celery	*Apium graveolens*	Cal. R. 1890.
Centaury	*Sabbatia angularis*	W. Va. B. 23.
Charlock	*Brassica arvensis*	N. J. R. 1890; W. Va. B. 23.
Cheat	*Bromus* species	Cal. R. 1890; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Cheeses	*Malva rotundifolia*	N. J. R. 1890; W. Va. B. 23.
Chess	*Bromus* species	Cal. R. 1890; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Chicken grass	*Eragrostis ciliaris*	Fla. B. 8.
Chickweed	*Stellaria media*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Chicory	*Cichorium intybus*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Chinese sumach	*Ailanthus glandulosa*	W. Va. B. 23.
Cinquefoil	*Potentilla canadensis*	N. J. R. 1890; W. Va. B. 22, B. 23.
Clearweed	*Pilea pumila*	W. Va. B. 23.
Climbing false buckwheat.	*Polygonum dumetorum*	Colo. R. 1890; N. J. R. 1890; W. Va. B. 23.
Clover dodder	*Cuscuta trifolii*	Cal. R. 1890; Iowa B. 13; Nev. B. 15; N. C. B. 70; W. Va. B. 23.
Cocklebur	*Xanthium strumarium*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23; Wis. B. 20.
Cocksfoot grass	*Panicum crus-galli*	Fla. B. 8; N. J. R. 1890.
Cockspur	*Cenchrus echinatus*	Fla. B. 8.
Coco grass	*Cyperus rotundus*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Coffeeweed	*Cassia occidentalis*	Fla. B. 8.
Colt's tail	*Erigeron canadensis*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Comfrey	*Symphytum officinale*	N. J. R. 1890.
Common agrimony	*Agrimonia eupatoria*	N. J. R. 1890; W. Va. B. 23.
Common fleabane	*Erigeron philadelphicus*	N. J. R. 1890.
Common rush	*Juncus marginatus*	N. J. R. 1890.
Common tare	*Vicia sativa*	N. J. 1890.
Common thistle	*Cnicus altissimus*	N. J. R. 1890.
Common vetch	*Vicia sativa*	N. J. R. 1890.
Compass weed	*Diodia teres*	Cal R. 1890; Fla. B. 8; N. J. R. 1890.
Cone flower	*Rudbeckia hirta*	N. J. R. 1890; W. Va. B. 22.
Corn chamomile	*Anthemis arvensis*	N. J. R. 1890; N. Y. Cornell B. 37.
Corn cockle	*Lychnis githago*	N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23
Corn poppy	*Papaver dubium*	W. Va. B. 23.
Corn speedwell	*Veronica arvensis*	N. J. R. 1890.
Corn spurry	*Spergula arvensis*	Cal. R. 1890; N. J. R. 1890.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Cotton head	*Frœlichia floridana*	Fla. B. 8.
Cottonweed	*Abutilon avicennæ*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Couch grass	*Agropyrum repens*	N. J. R. 1890; Wis. B. 20.
Cow herb	*Saponaria vaccaria*	Cal. R. 1890; N. J. R. 1890.
Cow parsnip	*Heracleum lanatum*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Crab grass	*Elusine indica*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Crab grass	*Panicum sanguinale*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Crab grass	*Paspalum digitaria*	Fla. B. 8.
Crane's-bill	*Geranium carolinianum*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Creeping buttercup	*Ranunculus repens*	N. J. R. 1890.
Creeping buttercup	*Ranunculus septentrionalis*	W. Va. B. 23.
Creeping greenhead	*Oldenlandia glomerata*	Fla. B. 8.
Crowdweed	*Lepidium campestre*	N. J. R. 1890; W. Va. B. 22, B. 23.
Crowfoot grass	*Elusine ægyptiacum*	Fla. B. 8.
Cudweed	*Gnaphalium obtusifolium*	N. J. R. 1890; W. Va. B. 23.
Cudweed	*Gnaphalium purpureum*	Fla. B. 8.
Curled dock	*Rumex crispus*	Cal. R. 1890; Fla. B. 8; Mich. B. 72; N. J. R. 1890; Wis. B. 20, B. 23.
Cut-leaved coneflower	*Rudbeckia laciniata*	N. J. R. 1890.
Cypress spurge	*Euphorbia cyparissias*	N. J. R. 1890.
Cypress vine	*Ipomœa quamoclit (Quamoclit vulgaris).*	Fla. B. 8.
Daisy fleabane	*Erigeron annuus*	N. J. R., 1890; W. Va. B. 22, B. 23.
Dame rocket	*Hesperis matronalis*	N. J. R. 1890.
Dandelion	*Taraxacum officinale*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Darnel	*Lolium perenne*	Cal. R. 1890; W. Va. B. 23.
Darnel	*Lolium temulentum*	Cal. R. 1890.
Date plum	*Diospyros virginiana*	W. Va. B. 23.
Day lily	*Hemerocallis fulva*	W. Va. B. 23.
Dead nettle	*Lamium amplexicaule*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Deergrass	*Rhexia virginica*	W. Va. B. 23.
Devil's gut	*Cuscuta trifolii*	Cal. R. 1890; Iowa B. 13; Nev. B. 15; N. C. B. 70; W. Va. B. 23.
Devil's ironweed	*Lactuca canadensis*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B 23.
Devil's plague	*Daucus carota*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Dewberry	*Rubus trivialis*	Fla. B. 8.
Dodder	*Cuscuta gronovii*	N. J. R. 1890; W. Va. B. 23.
Dogbur	*Cynoglossum officinale*	N. J. R. 1890; W. Va. B 23.
Dog fennel	*Anthemis cotula*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Dog's-tail grass	*Elusine indica*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Dogweed	*Verbesina encelioides*	Fla. B. 8.
Doorweed	*Polygonum aviculare*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. C. B. 70; N. J. R. 1890.
Downy vetch	*Vicia cracca*	Me. R. 1889, pt. III.
Dropseed grass	*Sporobolus indicus*	Fla. B. 8.
Dwarf dandelion	*Krigia amplexicaulis*	N. J. R. 1890; W. Va. B. 23.
Dwarf sumach	*Rhus copallina*	W. Va. B. 23.
Dwarf wild rose	*Rosa humilis*	N. J. R. 1890.
Eagle fern	*Pteris aquilina*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B 23
Early meadow rue	*Thalictrum dioicum*	N. J. R. 1890.
Eglantine	*Rosa rubiginosa*	W. Va. B. 23.
Elder	*Sambucus canadensis*	W. Va. B. 22, B. 23.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Elecampane	*Inula helenium*	N. J. R. 1890; W. Va. B. 22, B. 23.
English bluegrass	*Lolium perenne*	Cal. R. 1890; W. Va. B. 23.
English peppergrass	*Lepidium campestre*	N. J. R. 1890; W. Va. B. 22, B. 23.
English plantain	*Plantago lanceolata*	Cal. R. 1890; Iowa B. 13; Me. R. 1889, pt. III, R. 1890; Mich. B. 56, B. 72; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
English thistle	*Dipsacus sylvestris*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Erect knotgrass	*Polygonum erectum*	N. J. R. 1890.
Evening cockle	*Lychnis vespertina*	N. J. R. 1890.
Evening primrose	*Œnothera biennis*	Fla. B. 8; N. J. R. 1890.
Everlasting	*Gnaphalium obtusifolium*	N. J. R. 1890; W. Va. B. 23.
Eve's thread	*Hemerocallis fulva*	W. Va. B. 23.
Fall dandelion	*Leontodon autumnalis*	Me. R. 1890.
False flax	*Camelina sativa*	Me. R. 1889, pt. III; N. J. R. 1890.
False heliotrope	*Heliophytum indicum*	Fla. B. 8.
Feather grass	*Holcus lanatus*	W. Va. B. 23.
Fennel	*Helenium tenuifolium*	Fla. B. 8.
Feverfew	*Chrysanthemum parthenium*	N. J. R. 1890.
Field chamomile	*Anthemis arvensis*	N. J. R. 1890; N. Y. Cornell B. 37.
Field garlic	*Allium vineale*	N. J. R. 1890; W. Va. B. 22, B. 23.
Field gromwell	*Lithospermum arvense*	Mich. B. 72; N. J. R. 1890; W. Va. B. 23.
Field peppergrass	*Lepidium campestre*	N. J. R. 1890; W. Va. B. 22, B. 23.
Field poppy	*Papaver dubium*	W. Va. B. 23.
Field sorrel	*Rumex acetosella*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Field sow-thistle	*Sonchus arvensis*	N. J. R. 1890; Wis. B. 20.
Field violet	*Viola tenella*	W. Va. B. 23.
Figwort	*Scrophularia nodosa*	N. J. R. 1890.
Finger grass	*Panicum sanguinale*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Fireweed	*Epilobium spicatum*	N. J. R. 1890; W. Va. B. 23.
Fireweed	*Erechthites hieracifolia*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Five-finger	*Potentilla norvegica*	N. J. R. 1890.
Flax	*Linum usitatissimum*	N. J. R. 1890.
Flax dodder	*Cuscuta epilinum*	N. J. R. 1890; N. C. B. 70.
Fleabane	*Erigeron canadensis*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Florida clover	*Desmodium molle*	Fla. B. 8.
Florida dandelion	*Pyrrhopappus carolinianus*	Fla. B. 8.
Florida foxtail	*Alopecurus geniculatus*	Fla. B. 8.
Flower-of-an-hour	*Hibiscus trionum*	N. J. R. 1890; W. Va. B. 23.
Fog fruit	*Lippia lanceolata*	Fla. B. 8.
Forked sunflower	*Helianthus divaricatus*	N. J. R. 1890.
Foxtail grass	*Setaria glauca*	Cal. R. 1890; Fla. B. 8; Iowa B. 13; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
French mulberry	*Callicarpa americana*	Fla. B. 8.
Fuller's card	*Dipsacus sylvestris*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Galingale	*Cyperus esculentus*	N. J. R. 1890.
Garget	*Phytolacca decandra*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Garlic	*Allium vineale*	N. J. R. 1890; W. Va. B. 22, B. 23.
Germander	*Teucrium canadense*	N. J. R. 1890.
Gill-over-the-ground	*Nepeta hederacea* (*Nepeta glechoma*).	N. J. R. 1890; W. Va. B. 23.
Glade lily	*Lilium philadelphicum*	W. Va. B. 23.
Golden hawkweed	*Hieracium aurantiacum*	Iowa B. 13; N. Y. Cornell B. 37.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Golden ragweed	*Senecio aureus*	N. J. R. 1890.
Golden-rod	*Solidago juncea*, etc	N. J. R. 1890; W. Va. B. 23.
Gold-of-pleasure	*Camelina sativa*	Me. R. 1889, pt. III; N. J. R. 1890.
Goosefoot	*Chenopodium album*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23; Wis. B. 20.
Goosefoot	*Chenopodium hybridum*	N. J. R. 1890.
Goosefoot	*Chenopodium urbicum*	N. J. R. 1890.
Goose grass	*Cyperus*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Goose grass	*Polygonum aviculare*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Great ragweed	*Ambrosia trifida*	Fla. B. 8; N. J. R. 1890; W Va. B. 22, B. 23.
Great willow-herb	*Epilobium spicatum*	N. J. R. 1890; W. Va. B. 23.
Green brier	*Smilax rotundifolia*	N. J. R. 1890.
Green foxtail	*Setaria viridis*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Gromwell	*Lithospermum officinale*	Mich. B. 72; N. J. R. 1890; W. Va. B. 23.
Ground cherry	*Physalis virginiana*	N. J. R. 1890.
Ground ivy	*Nepeta hederacea*	N. J. R. 1890; W. Va. B. 23.
Groundsel	*Senecio aureus*	N. J. R. 1890.
Groundsel	*Senecio vulgaris*	Cal. R. 1890; N. J. R. 1890.
Hairy ground cherry	*Physalis pubescens*	Fla. B. 8; N. J. R. 1890.
Hairy mint	*Blephilia hirsuta*	W. Va. B. 23.
Hairy pursley	*Portulaca pilosa*	Fla. B. 8.
Harbinger-of-spring	*Erigenia bulbosa*	W. Va. B. 23.
Hawkweed	*Hieracium aurantiacum*	Iowa B. 13; N. Y. Cornell B. 37.
Heal-all	*Brunella vulgaris*	N. J. R. 1890; W. Va. B. 23.
Heart-leaved aster	*Aster cordifolius*	N. J. R. 1890; W. Va. B. 22, B. 23.
Heath-like aster	*Aster ericoides*	N. J. R. 1890.
Hedgehog grass	*Cenchrus tribuloides*	Fla. B. 8; N. J. R. 1890.
Hedge mustard	*Erysimum officinale*	Cal. R. 1890.
Hedge mustard	*Sisymbrium officinale*	N. J. R. 1890.
Hedge nettle	*Stachys aspera*	N. J. R. 1890.
Hedge nettle	*Stachys floridana*	Fla. B. 8.
Hemp	*Cannabis sativa*	N. J. R. 1890.
Henbit	*Lamium amplexicaule*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Hercules' club	*Aralia spinosa*	W. Va. B. 23.
High blackberry	*Rubus strigosus*	N. J. R. 1890.
Hogweed	*Ambrosia artemisiæfolia*	Fla. B. 8; N. C. B. 70; N. J. R. 1890; W. Va. B. 22, B. 23.
Honey locust	*Gleditschia triacanthos*	W. Va. B. 23.
Horehound	*Marrubium vulgare*	N. J. R. 1890; W. Va. B. 23.
Horn poppy	*Glaucium luteum*	W. Va. B. 23.
Horsemint	*Monarda punctata*	Fla. B. 8.
Horse-radish	*Nasturtium armoracia*	N. J. R. 1890; W. Va. B. 23.
Horse sorrel	*Rumex acetosella*	Fla. B. 8; Cal. R. 1890; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Horsetail rush	*Equisetum arvense*	N. J. R. 1890; W. Va. B. 23.
Horseweed	*Ambrosia trifida*	Fla B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Horseweed	*Lactuca canadensis*	Fla. B. 8, N. J. R. 1890; W. Va. B. 22, B. 23.
Horseweed	*Erigeron canadensis*	Fla. B. 8; Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Hound's-tongue	*Cynoglossum officinale*	N. J. R. 1890; W. Va. B. 23.
Hypericum spurge	*Euphorbia hypericifolia*	Fla. B. 8; N. J. R. 1890.
Indian cure-all	*Croton argyranthemum*	Fla. B. 8.
Indian fig	*Opuntia vulgaris*	Fla. B. 8; N. J. R. 1890.
Indian flax	*Crotonopsis linearis*	Fla. B. 8.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Indian hemp	*Apocynum androsæmifolium.*	N. J. R. 1890; W. Va. B. 22, B. 23.
Indian mallow	*Abutilon avicennæ*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22. B. 23.
Indian plantain	*Cacalia* species	W. Va. B. 23.
Indian shot	*Canna flaccida*	Fla. B. 8.
Indian thistle	*Dipsacus sylvestris*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22. B. 23.
Indian tobacco	*Lobelia inflata*	N. J. R. 1890; W. Va. B. 23.
Indigo	*Indigofera tinctoria*	Fla. B. 8.
Innocence	*Houstonia cærulea*	W. Va. B. 23.
Ipecac weed	*Richardsonia scabra*	Fla. B. 8.
Ironweed	*Vernonia novaboracen is*	N. J. R. 1890; W. Va. B. 22.
Jamestown weed, or Jimson.	*Datura meteloides*	Cal. R. 1890; N. J. R. 1890.
Jamestown weed	*Datura stramonium*	Fla. B. 8; N. C. B. 70; W. Va. B. 22, B. 23.
Jamestown weed	*Datura tatula*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Japanese clover	*Lespedeza striata*	Fla. B. 8; W. Va. B. 23
Jersey tea	*Ceanothus microphyllus*	Fla. B. 8.
Jerusalem artichoke	*Helianthus tuberosus*	N. J. R. 1890.
Jerusalem oak	*Chenopodium botrys*	N. J. R. 1890.
Joe-Pye weed	*Eupatorium purpureum*	N. J. R. 1890.
Johnson grass	*Paspalum halepense*	Cal. R. 1890.
Jointed charlock	*Raphanus raphanistrum*	N. J. R. 1890; W. Va. B. 23.
Julip mint	*Mentha viridis*	N. J. R. 1890; W. Va. B. 23.
Kneegrass	*Panicum proliferum*	N. C. B. 70.
Knotgrass	*Polygonum aviculare*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Lady's thumb	*Polygonum persicaria*	Fla. B. 8; N. J. R. 1890.
Lamb's-quarters	*Chenopodium album*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23; Wis. B. 20.
Late golden-rod	*Solidago serotina*	N. J. R. 1890.
Leafcup	*Polymnia* species	W. Va. B. 23.
Lesser willow herb	*Epilobium coloratum*	N. J. R. 1890.
Life everlasting	*Gnaphalium polycephalum*	Fla. B. 8.
Live-forever	*Sedum telephium*	N. J. R. 1890.
Louisiana grass	*Paspalum platycaule*	Fla. B. 8.
Lousewort	*Pedicularis canadensis*	N. J. R. 1890.
Low cudweed	*Gnaphalium uliginosum*	W. Va. B. 23.
Low hop-clover	*Trifolium procumbens*	N. J. R. 1890.
Low vervain	*Verbena angustifolia*	W. Va. B. 23.
Maiden cane	*Panicum curtisii*	Fla. B. 8.
Mallard	*Malva rotundifolia*	N. J. R. 1890; W. Va. B. 23.
Mandrake	*Podophyllum peltatum*	N. J. R. 1890; W. Va. B. 23.
Man-of-the-earth	*Ipomœa pandurata*	N. J. R. 1890; W. Va. B. 22, B. 23.
Marigold	*Bidens connata*	N. J. R. 1890; W. Va. B. 22.
Marsh cress	*Nasturtium palustre*	N. J. R. 1890.
Masterwort	*Heracleum lanatum*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 23.
Matrimony vine	*Lycium vulgare*	N. J. R. 1890.
May apple	*Podophyllum peltatum*	N. J. R. 1890; W. Va. B. 23.
Maypop	*Passiflora incarnata*	Fla. B. 8.
Mayweed	*Anthemis cotula*	Fla. B. 8; N. J. R., 1890; N. C. B. 70; W. Va 22. B. 23.
Meadow beauty	*Rhexia virginica*	W. Va. B. 23.
Meadow parsnip	*Thaspium aureum*	N. J. R. 1890.
Melilot	*Melilotus officinalis*	N. J. R. 1890.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Mexican tea	*Chenopodium ambrosioides*	Cal. R. 1890; N. J. R. 1890.
Milfoil	*Achillea millefolium*	N. J. R. 1890; W. Va. B. 22, B. 23.
Milk purslane	*Euphorbia maculata*	Colo. R. 1890; Fla. B. 8; N. J. R. 1890.
Milk thistle	*Sonchus oleraceus*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Milkweed	*Asclepias syriaca*	N. J. R. 1890; W. Va. B. 22, B. 23.
Mistflower	*Eupatorium cœlestinum*	W. Va. B. 23.
Moonflower	*Ipomœa bona-nox*	Fla. B. 8.
Moonwort	*Botrychium ternatum*	W. Va. B. 23.
Morning-glory	*Ipomœa nil*	N. J. R. 1890.
Morning-glory	*Ipomœa purpurea*	N. J. R. 1890; W. Va. B. 22, B. 23.
Motherwort	*Leonurus cardiaca*	N. J. R. 1890.
Moth mullein	*Verbascum blattaria*	Mich. B. 72; N. J. R. 1890.
Mountain mint	*Pycnanthemum flexuosum*	W. Va. B. 23.
Mouse-ear chickweed	*Cerastium viscosum*	N. J. R. 1890.
Mouse-ear chickweed	*Cerastium vulgatum*	W. Va. B. 23.
Mouse-ear cress	*Sisymbrium thaliana*	N. J. R. 1890.
Mugwort	*Artemisia vulgaris*	N. J. R. 1890.
Mullein	*Verbascum thapsus*	N. J. R. 1890; W. Va. B. 22.
Musky alfilerilla	*Erodium moschatum*	Cal. R. 1890.
Narrow-leaved stick-seed.	*Echinospermum lappula*	N. J. R. 1890.
Native plantain	*Plantago rugellii*	N. J. R. 1890; W. Va. B. 23.
Neckweed	*Veronica peregrina*	Cal. R. 1890; N. J. R. 1890.
Nettle-leaved vervain	*Verbena urticæfolia*	N. J. R. 1890; W. Va. B. 23.
New England aster	*Aster novæ angliæ*	N. J. R. 1890.
Nigger head	*Rudbeckia hirta*	N. J. R. 1890; W. Va. B. 22.
Nightshade	*Solanum nigrum*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Nonesuch	*Medicago lupulina*	N. J. R. 1890.
Norway cinquefoil	*Potentilla norvegica*	N. J. R. 1890.
Nut grass	*Cyperus rotundus*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Nut sedge	*Scleria laxa*	Fla. B. 8.
Old whitetop	*Holcus lanatus*	W. Va. B. 23.
Old witch grass	*Panicum capillare*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Oxeye daisy	*Chrysanthemum leucanthemum.*	Cal. R. 1890; Iowa B. 13; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23; Wis. B. 20.
Oyster plant	*Tragopogon porrifolius*	N. J. R. 1890.
Pale lamb's-quarters	*Chenopodium urbicum*	N. J. R. 1890.
Pale touch-me-not	*Impatiens aurea (I. pallida)*	N. J. R. 1890.
Panic grass	*Panicum dichotomum*	Fla. B. 8; N. J. R. 1890.
Papaw	*Asimina* species	Fla. B. 8; W. Va. B. 23.
Paraguay bur	*Acanthospermum xanthioides*	Fla. B. 8.
Partridge pea	*Cassia chamæchrista*	Fla. B. 8.
Passion flower	*Passiflora incarnata*	Fla. B. 8.
Pasture thistle	*Cnicus lanceolatus*	Fla. B. 8; Iowa B. 13; N. J. R. 1890; W. Va. B. 22, B. 23.
Pasture thistle	*Cnicus odoratus*	N. J. R. 1890; W. Va. B. 23.
Pennsylvania smart-weed.	*Polygonum pennsylvanicum*	Cal. R. 1890; N. J. R. 1890.
Pennyroyal	*Hedeoma pulegioides*	N. J. R. 1890.
Pennywort	*Hydrocotyle umbellata*	Fla. B. 8.
Peppergrass	*Lepidium virginicum*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Peppergrass	*Sisymbrium canescens*	Fla. B. 8.
Peppermint	*Mentha piperita*	N. J. R. 1890; W. Va. B. 23.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Persimmon	*Diospyros virginiana*	W. Va. B. 23.
Pigeon berry	*Phytolacca decandra*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Pigeon grass	*Setaria glauca*	Cal. R. 1890; Fla. B. 8; Iowa B. 13; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Pigeon weed	*Lithospermum arvense*	Mich. B. 72; N. J. R. 1890; W. Va. B. 23.
Pigweed	*Amarantus albus*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890.
Pigweed	*Chenopodium album*	Cal. R. 1890; Colo. B. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23; Wis. B. 20.
Pigweed	*Chenopodium hybridum*	N. J. R. 1890.
Pigweed amaranth	*Amarantus chlorostachys*	Fla. B. 8; N. J. R. 1890.
Pimpernel	*Anagallis arvensis*	Cal. R. 1890; N. J. R. 1890.
Pink bloom	*Sabbatia angularis*	W. Va. B. 23.
Pitchfork	*Bidens frondosa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Plantain	*Plantago* species	Cal. R. 1890; Iowa B. 13; Me. R. 1889, pt. III, R. 1890; Mich. B. 56, B. 72; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Plantain-leaved everlasting	*Antennaria plantaginifolia*	N. J. R. 1890.
Pleurisy root	*Asclepias tuberosa*	N. J. R. 1890; W. Va. B. 23.
Poison chickweed	*Anagallis arvensis*	Cal. R. 1890; N. J. R. 1890.
Poison hemlock	*Conium maculatum*	N. J. R. 1890.
Poison ivy	*Rhus radicans (R. toxicodendron).*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Pokeweed	*Phytolacca decandra*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Poor man's weatherglass.	*Anagallis arvensis*	Cal. R. 1890; N. J. R. 1890.
Poverty grass	*Aristida purpurascens*	Fla. B. 8.
Poverty grass	*Eleocharis tenuis*	W. Va. B. 23.
Poverty grass	*Juncus tenuis*	N. J. R. 1890; W. Va. B. 23.
Prairie grass	*Paspalum ciliatifolium*	Fla. B. 8.
Prickly mint	*Leonotis nepetæfolia*	Fla. B. 8.
Prickly pear	*Opuntia vulgaris*	Fla. B. 8; N. J. R. 1890.
Prickly tarweed	*Centaurea* species	Cal. R. 1890.
Puccoon	*Lithospermum officinale*	N. J. R. 1890.
Purple meadow rue	*Thalictrum purpurascens*	N. J. R. 1890.
Purple thorn apple	*Datura tatula*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22.
Purslane	*Portulaca oleracea*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 23.
Purslane speedwell	*Veronica peregrina*	Cal. R. 1890; N. J. R. 1890.
Pusley or Pursley	*Portulaca oleracea*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 23.
Pussgrass	*Setaria glauca*	Cal. R. 1890; Fla. B. 8; Iowa B. 13; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Quack grass	*Agropyrum repens*	N. J. R. 1890; Wis. B. 20.
Queen's delight	*Stillingia sylvatica*	Fla. B. 8.
Queen-weed	*Pastinaca sativa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Quick grass	*Agropyrum repens*	N. J. R. 1890; Wis. B. 20.
Rabbit-foot clover	*Trifolium arvense*	N. J. R. 1890; W. Va. B. 23.
Ragweed	*Ambrosia artemisiæfolia*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Ramsted	*Linaria vulgaris*	Mich. B. 72; N. J. R. 1890; W. Va. B. 22; Wis. B. 20.
Rape	*Raphanus raphanistrum*	N. J. R. 1890; W. Va. B. 23.
Rattlebox	*Crotallaria sagittalis*	N. J. R. 1890.
Rattleroot	*Cimicifuga racemosa*	W. Va. B. 23.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Red sorrel	*Rumex acetosella*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Redweed	*Rumex acetosella*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Redweed	*Rumex engelmanni*	Fla. B. 8.
Rheumatism weed	*Apocynum androsæmifolium*	N. J. R. 1890; W. Va. B. 22, B. 23.
Rib grass	*Plantago lanceolata*	Cal. R. 1890; Iowa B. 13; Me. R. 1889, pt. III, R. 1890; Mich. B. 56, B. 72; N. J. R. 1890; W. Va. B. 22, B. 23.
Richweed	*Ambrosia artemisiæfolia*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Ripple grass	*Plantago lanceolata*	Cal. R. 1890; Iowa B. 13; Me. R. 1889, pt. III, R. 1890; Mich. B. 56, B. 72; N. J. R. 1890; W. Va. B. 22, B. 23.
Robin's plantain	*Erigeron bellidifolius*	N. J. R. 1890.
Roman wormwood	*Ambrosia artemisiæfolia*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Rough hawkweed	*Hieracium scabrum*	N. J. R. 1890.
Rough-stemmed fleabane.	*Erigeron ramosus*	N. J. R. 1890.
Round-leaved mallow	*Malva rotundifolia*	N. J. R. 1890; W. Va. B. 23.
Rutland beauty	*Convolvulus sepium*	N. J. R. 1890.
Salsify	*Tragopogon porrifolius*	N. J. R. 1890.
Sand brier	*Solanum carolinense*	Fla. B. 8; Iowa B. 13; N. J. R. 1890; W. Va. B. 22, B. 23.
Sand lupine	*Lupinus formosus*	Cal. R. 1890.
Sand purslane	*Sesuvium pentandrum*	Fla. B. 8.
Sand spur	*Cenchrus tribuloides*	Fla. B. 8; N. J. R. 1890.
Scoke	*Phytolacca decandra*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Scouring rush	*Equisetum arvense*	N. J. R. 1890; W. Va. B. 23.
Scutch grass	*Cynodon dactylon*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Sedge	*Carex* species	Fla. B. 8.
Sedge	*Cyperus esculentus*	N. J. R. 1890.
Self-heal	*Brunella vulgaris*	N. J. R. 1890; W. Va. B. 23.
Sensitive brier	*Schrankia uncinata*	Fla. B. 8.
Sensitive fern	*Onoclea sensibilis*	N. J. R. 1890.
Sensitive plant	*Mimosa strigillosa*	Fla. B. 8.
Sheep sorrel	*Rumex acetosella*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. 22, B. 23.
Shepherd's purse	*Capsella bursa-pastoris*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 22; Wis. B. 20.
Showy spurge	*Euphorbia corollata*	N. J. R. 1890.
Silkweed	*Asclepias syriaca*	N. J. R. 1890; W. Va. B. 22, B. 23.
Skullcap	*Scutellaria* species	W. Va. B. 23.
Skunk cabbage	*Symplocarpus fœtidus*	N. J. R. 1890; W. Va. B. 23.
Slender chess	*Bromus tectorum*	N. J. R. 1890.
Slender fivefinger	*Potentilla canadensis*	N. J. R. 1890; W. Va. B. 22, B. 23.
Slender nettle	*Urtica gracilis*	N. J. R. 1890; W. Va. B. 23.
Slender rush	*Juncus tenuis*	N. J. R. 1890; W. Va. B. 23.
Small beggar's ticks	*Bidens cernua*	N. J. R. 1890.
Small flowered buttercup.	*Ranunculus abortivus*	W. Va. B. 23.
Smartweed	*Polygonum* species	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; Me. R. 1890, pt. III; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23; Wis. B. 20.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Smooth sumach	*Rhus glabra*	N. J. R. 1890; W. Va. B. 23.
Sneezeweed	*Helenium autumnale*	S. C. R. 1889.
Soft brome grass	*Bromus mollis*	Cal. R. 1890.
Sorrel	*Rumex acetosella*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Sow thistle	*Sonchus oleraceus*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Spanish bur	*Urena lobata*	Fla. B. 8.
Spanish needles	*Bidens bipinnata*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Spearmint	*Mentha viridis*	N. J. R. 1890; W. Va. B. 23.
Speedwell	*Veronica serpyllifolia*	N. J. R. 1890; W. Va. B. 23.
Spiderwort	*Commelina communis*	Fla. B. 8.
Spiderwort	*Tradescantia virginica*	N. J. R. 1890.
Spiny amaranth	*Amaranthus spinosus*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Spiny cocklebur	*Xanthium spinosum*	Cal. R. 1890; N. J. R. 1890; N. C. B. 70; W. Va. B. 23.
Spiny-leaved sow thistle.	*Sonchus asper*	Fla. B. 8; N. J. R. 1890.
Spiny nightshade	*Solanum rostratum*	Iowa B. 13; N. J. R. 189?
Spotted cow-bane	*Cicuta maculata*	W. Va. B. 23.
Spotted crane's bill	*Geranium maculatum*	N. J. R. 1890.
Spotted knotweed	*Polygonum persicaria*	Fla. B. 8; N. J. R. 1890.
Spotted spurge	*Euphorbia maculata*	Col. R. 1890; Fla. B. 8; N. J. R. 1890.
Spotted touch-me-not	*Impatiens biflora (I. fulva)*	N. J. R. 1890.
Spreading aster	*Aster patens*	N. J. R. 1890.
Spreading dogbane	*Apocynum androsæmifolium*	N. J. R. 1890; W. Va. B. 22, B. 23.
Spurge	*Euphorbia* species	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Spurge nettle	*Jatropha urens*, var. *stimulosa*.	Fla. B. 8.
Spurry	*Spergula arvensis*	Cal. R. 1890; N. J. R. 1890.
Squawroot	*Cimicifuga racemosa*	W. Va. B. 23.
Squawweed	*Senecio aureus*	N. J. R. 1890.
Squirrel-tail grass	*Hordeum jubatum*	N. J. R. 1890.
Star cucumber	*Licyos angulatus*	N. J. R. 1890.
Star grass	*Sisyrinchium bellum*	Cal. R. 1890.
Starved aster	*Aster lateriflorus*	N. J. R. 1890; W. Va. B. 22, B. 23.
Stemless primrose	*Œnothera ovata*	Cal. R. 1890.
Stick-seed	*Bidens frondosa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Stick-seed	*Echinospermum* species	Colo. R. 1890; N. J. R. 1890.
Stick-tights	*Desmodium* species	Fla. B. 8; W. Va. B. 22.
Stinking grass	*Eragrostis major*	N. J. R. 1890.
St. Johnswort	*Hypericum perforatum*	N. J. R. 1890; W. Va. B. 23.
Stoneseed	*Lithospermum arvense*	Mich. B. 72; N. J. R. 1890; W. Va. B. 23.
Stoneweed	*Lithospermum arvense*	Mich. B. 72; N. J. R. 1890; W. Va. B. 23.
Storksbill	*Erodium cicutarium*	Cal. R. 1890; N. J. R. 1890.
Stramonium	*Datura stramonium*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22.
Summer foxtail	*Setaria glauca*	Cal. R. 1890; Fla. B. 8; Iowa B. 13; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Sundrops	*Œnothera fruticosa*	W. Va. B. 23.
Sunflower	*Helianthus annuus*	Cal. R. 1890; Colo. R. 1890; N. J. R. 1890.
Swamp beggar-ticks	*Bidens connata*	N. J. R. 1890; W. Va. B. 22.
Swamp rose	*Rosa carolina*	W. Va. B. 23.
Sweetbrier	*Rosa rubiginosa*	W. Va. B. 23.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Sweet clover	*Melilotus indica*	Cal. R. 1890.
Sweet scabious	*Erigeron annuus*	N. J. R. 1890; W. Va. B. 22, B. 23.
Sweet sedge	*Kyllingia sesquiflora*	Fla. B. 8.
Sweet William	*Silene armeria*	N. J. R. 1890.
Tall crowfoot	*Ranunculus acris*	N. J. R. 1890; W. Va. B. 23.
Tall meadow rue	*Thalictrum polygamum*	N. J. R. 1890; W. Va. B. 23.
Tall ragweed	*Ambrosia trifida*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Tall thistle	*Dipsacus sylvestris*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Tansy	*Tanacetum vulgare*	N. J. R. 1890.
Tarweed	*Cuphæa petiolata*	W. Va. B. 22, B. 23.
Tasselvine	*Mimosa strigillosa*	Fla. B. 8.
Teasle	*Dipsacus sylvestris*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Teaweed	*Sida stipulacea*	Fla. B. 8.
Thimbleberry	*Rubus occidentalis*	N. J. R. 1890.
Thorn apple	*Datura stramonium*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22.
Thorny amaranth	*Amarantus spinosus*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Thoroughwort	*Eupatorium perfoliatum*	N. J. R. 1890.
Three-seeded mercury	*Acalypha virginica*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Three-thorned acacia	*Gleditschia triacanthos*	W. Va. B. 23.
Thyme-leaved sandwort	*Arenaria serpyllifolia*	N. J. R. 1890.
Tickle grass	*Panicum capillare*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Tickseed	*Desmodium* species	Fla. B. 8; W. Va. B. 22.
Toadflax	*Linaria canadensis*	Fla. B. 8; N. J. R. 1890.
Toadflax	*Linaria vulgaris*	Mich. B. 72; N. J. R. 1890; W. Va. B. 22, B. 23; Wis. B. 20.
Trailing tarweed	*Chamæbatia foliolosa*	Cal. R. 1890.
Tree of heaven	*Ailanthus glandulosa*	W. Va. B. 23.
Trumpet creeper	*Tecoma radicans*	W. Va. B. 23.
Trumpet milkweed	*Lactuca integrifolia*	Fla. B. 8.
Trumpetweed	*Eupatorium purpureum*	N. J. R. 1890.
Tumbleweed	*Amarantus albus*	Cal. R. 1890; Colo. R. 1890; Fla. B. 8; N. J. R. 1890.
Turnip	*Brassica campestris*	N. J. R. 1890.
Velvet grass	*Holcus lanatus*	W. Va. B. 23.
Velvetleaf	*Abutilon avicennæ*	Fla. B. 8; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23.
Violet clover	*Lespedeza violacea*	W. Va. B. 23.
Viper's bugloss	*Echium vulgare*	N. J. R. 1890; W. Va. B. 22, B. 23.
Virginia creeper	*Vitis quinquefolia (Ampelopsis quinquefolia).*	W. Va. B. 23; Fla. B. 8.
Virginia thistle	*Cnicus virginianus*	W. Va. B. 23.
Water hemlock	*Cicuta maculata*	W. Va. B. 23.
Water hemp	*Acnida australis*	Fla. B. 8.
Water horehound	*Lycopus sinuatus*	N. J. R. 1890.
Water pepper	*Polygonum hydropiper*	N. J. R. 1890.
Water smartweed	*Polygonum emersum*	N. J. R. 1890.
Water thistle	*Dipsacus sylvestris*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Wet Bermuda grass	*Paspalum distichum*	Fla. B. 8.
Wheat thief	*Lithospermum arvense*	Mich. B. 72; N. J. R. 1890; W. Va. B. 23.
White clover	*Trifolium repens*	N. J. R. 1890.
White devil	*Aster lateriflorus*	N. J. R. 1890; W. Va. B. 22, B. 23.
White man's foot	*Plantago major*	Cal. R. 1890; N. J. R. 1890.
White melilot	*Melilotus alba*	N. J. R. 1890; W. Va. B. 23.
White mullein	*Verbascum lychnitis*	N. J. R. 1890.

List of weeds in the United States, with references to Station publications—Continued.

Common name.	Scientific name.	Station publications.
White mustard	*Brassica alba*	N. J. R. 1890.
White plantain	*Plantago virginica*	W. Va. B. 23.
White poplar	*Populus alba*	W. Va. B. 23.
Whitetop	*Erigeron annuus*	N. J. R. 1890; W. Va. B. 22, B. 23.
White vervain	*Verbena urticæfolia*	N. J. R. 1890; W. Va. B. 23.
Whiteweed	*Chrysanthemum leucanthemum.*	Cal. R. 1890; Iowa B. 13; N. J. R. 1890; N. C. B. 70; W. Va. B. 22, B. 23; Wis. B. 20.
Whorled foxtail	*Setaria verticillata*	N. J. R. 1890.
Wild balsam apple	*Micrampeles echinata (Echinocystis lobata).*	W. Va. B. 23.
Wild bean	*Phaseolus perennis*	Fla. B. 8.
Wild beet	*Œnothera fruticosa*	W. Va. B. 23.
Wild bergamont	*Monarda fistulosa*	W. Va. B. 23.
Wild buckwheat	*Polygonum convolvulus*	Fla. B. 8; Me. R. 1889, pt. III; N. J. R. 1890; Wis. B. 20.
Wild carrot	*Daucus carota*	Cal. R. 1890; N. J. R. 1890; W. Va. B. 22, B. 23.
Wild cotton	*Asclepias syriaca*	N. J. R. 1890; W. Va. B. 22, B. 23.
Wild garlic	*Allium canadense*	N. J. R. 1890.
Wild gourd	*Cucurbita fœtida*	Cal. R. 1890.
Wild hydrangea	*Hydrangea arborescens*	W. Va. B. 23.
Wild leek	*Allium tricoccum*	N. J. R. 1890.
Wild lettuce	*Lactuca canadensis*	Fla. B. 8; N. J. R. 1890; W. Va. B. 22, B. 23.
Wild licorice	*Glycyrrhiza lepidota*	Cal. R. 1890.
Wild lily	*Lilium philadelphicum*	W. Va. B. 23.
Wild mint	*Mentha canadensis*	N. J. R. 1890.
Wild mustard	*Brassica sinapistrum*	Wis. B. 20.
Wild-oat grass	*Arrhenatherum elatius*	W. Va. B. 23.
Wild oats	*Avena fatua*	Cal. R. 1890.
Wild onion	*Allium vineale*	N. J. R. 1890; W. Va. B. 22, B. 23.
Wild parsnip	*Pastinaca sativa*	N. J. R. 1890; W. Va. B. 22, B. 23.
Wild pink	*Silene pennsylvanica*	Me. R. 1889, pt. III.
Wild radish	*Raphanus raphanistrum*	N. J. R. 1890; W. Va. B. 23.
Wild red raspberry	*Rubus strigosus*	N. J. R. 1890.
Wild rose	*Rosa carolina*	W. Va. B. 23.
Wild senna	*Cassia marilandica*	Fla. B. 8; W. Va. B. 23.
Wild sunflower	*Helianthus strumosus*	Fla. B. 8.
Wild sweet potato	*Ipomœa pandurata*	N. J. R. 1890; W. Va. B. 22, B. 23.
Wild sweet William	*Phlox maculata*	W. Va. B. 23.
Wild timothy	*Setaria viridis*	Fla. B. 8; N. J. R. 1890; N. C. B. 70.
Wild tobacco	*Nicotiana attenuata*	Cal. R. 1890.
Wingstem	*Actinomeris alternifolia*	W. Va. B. 22, B. 23.
Wire grass	*Aristida* species	Fla. B. 8.
Wire grass	*Elusine indica*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Wire grass	*Sporobolus* species	Fla. B. 8.
Witch grass	*Eragrostis capillaris*	Fla. B. 8.
Woodrush	*Luzula campestris*	W. Va. B. 23.
Wood sage	*Teucrium canadense*	N. J. R. 1890.
Wool mat	*Cynoglossum officinale*	N. J. R. 1890; W. Va. B. 23.
Wormseed	*Chenopodium ambrosioide* var. *anthelminticum.*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Yard grass	*Elusine indica*	Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Yarrow	*Achillea millefolium*	N. J. R. 1890; W. Va. B. 22, B. 23.
Yellow daisy	*Rudbeckia hirta*	N. J. R. 1890; W. Va. B. 22, B. 23.
Yellow dock	*Rumex crispus*	Cal. R. 1890; Fla. B. 8; Mich. B. 72; N. J. R. 1890; W. Va. B. 23; Wis. B. 20.

List of weeds in the United States, with references to station publications—Continued.

Common name.	Scientific name.	Station publications.
Yellow hop clover	*Trifolium agrarium*	N. J. R. 1890; W. Va. B. 23.
Yellow locust	*Robinia pseudacacia*	W. Va. B. 23.
Yellow mustard	*Brassica arvensis*	N. J. R. 1890; W. Va. B. 23.
Yellow rocket	*Barbarea vulgaris*	N. J. R. 1890.
Yellow sweet clover	*Melilotus officinalis*	N. J. R. 1890.
Yellow wood sorrel	*Oxalis corniculata* var. *stricta*	Cal. R. 1890; Fla. B. 8; N. J. R. 1890; W. Va. B. 23.
Yerba mansa	*Anemopsis californica*	Cal. R. 1890.

West Virginia Station, Morgantown.—Organized under act of Congress in 1888 as a department of the West Virginia University. The staff consists of the president of the university, director, botanist, entomologist, agriculturist, chemist, stenographer and bookkeeper, and treasurer. The principal lines of work are analysis and control of fertilizers; chemistry; botany; field experiments with field crops, vegetables, and fruits; and entomology. Up to January 1, 1893, the station had published 3 annual reports and 29 bulletins. Revenue in 1892, $19,904.

Whale-oil soap.—See *Insecticides.*

Wheat (*Triticum vulgare*).—VARIETIES.—A number of the stations have made tests of varieties, some of them extending over a series of years. In general the results have indicated that the selection of varieties depends on local conditions of soil and climate. At the Ohio Station, where tests have been made for ten years, the following varieties are especially commended: Valley, Nigger, Penquite Velvet Chaff, and Diehl Mediterranean among the red-bearded varieties; of the smooth red varieties, the Red Fultz, Poole, and Finley; of white varieties, Silver Chaff (smooth), Master's Amber, and Democrat. At Indiana Station Velvet Chaff has averaged about 32 bushels per acre during seven years. In Pennsylvania, Dietz Longberry Red, Fulcaster, and Fultz have been among the best varieties. In Kansas several years' experience indicate that "fine early-ripening red sorts," like Early May and Zimmerman, are the best for that region.

The average of many varieties of wheat for ten years gives the following yields per acre of the different classes at the Ohio Station: White wheat, 30.8 bushels per acre; red wheat, 31.5 bushels; bearded wheat, 31.7 bushels; smooth wheat, 31.1 bushels. The difference is so slight as to suggest that one kind is about as reliable as another. (*Ohio B., vol. III, 6.*)

(*Ala. Canebrake B. 5; Ala. College B. 32, n. ser., B. 39, n. ser.; Ark. B. 6, B. 11, R. 1888, p. 35; Colo. R. 1888, p. 43, R. 1890, p. 19, R. 1891, p. 114; Ill. B. 17; Ind. B. 4, B. 8, B. 16, B. 32, R. 1880, p. 31, R. 1881, p. 80, R. 1882, p. 61, R, 1883, p. 67, R. 1888, p. 19; Iowa B. 15; Kans. B. 7, B. 11, B. 33, R. 1888, p. 54; Ky. B. 8, B. 30, B. 35, R. 1888, pp. 89, 115; La. B. 26; Md. B. 10, B. 14; Mich. B. 18, B. 38, R. 1888, p. 83; Minn. B. 1, B. 15; Miss. R. 1891, p. 24; Mo. College B. 3, B. 15; Nebr. B. 12, B. 15, B. 19; Nev. R. 1891, p. 20; N. Mex. B. 6; N. Y. State R. 1887, p. 58, R. 1890, p. 369, B. 4, B. 45; N. C. B. 71; Ohio B. 1, B. 5, B. 16, vol. III, 6, R. 1883, p. 10, R. 1888, p. 23, R. 1889, p. 115; Ore. B. 4, B. 16; Pa. B. 6, R. 1888, pp. 35, 120, R. 1889, pp. 18, 150, R. 1890, p. 144; S. C. B. 5, B. 4, n. ser., B. 7, n. ser., R. 1889, p. 206; S. Dak. B. 11, B. 21, R. 1888, p. 87; Tenn. R. 1882, p. 5, R. 1885–86, p. 13; Va. B. 19; Wis. B. 11, B. 13.*)

COMPOSITION.—See *Appendix, Tables I and II.*

At the Connecticut Storrs Station (*R. 1888, p. 38*) it was found that roots of wheat leave in the soil per acre water-free substance 6.58, nitrogen 6.4, phosphoric acid 1.5, and potash 2.6 pounds.

CULTURE.—In Ohio during seven seasons with one exception the highest yields were obtained by seeding the last week in September or the first in October (*Ohio B.*

vol. III, 6). Seeding in October is not safe in Illinois (*Ill. B. 11*). In Indiana seeding at different dates gave conflicting results (*Ind. B. 32*).

At several stations sowing from 5 to 8 pecks per acre has given the best yields during a series of years (*Ill. B. 11; Ind. B. 32; Kans. B. 20; Ky. B. 21; Minn. B. 15; Ohio B. vol. II, 5, B. vol. III, 6, B. 42; S. Dak. B. 11*).

At Indiana Station large seed gave better results than small seed. At the Kansas Station, mature seed wheat proved superior to immature (*Kans. B. 33*). Analyses and field experiments at Minnesota Station with regard to the use of rusted, frosted, and frozen grain for seed indicated that, (1) different kinds of poor wheat differ widely in value for seed, (2) rusted and blistered wheat if well cleaned can be safely used for seed, while frozen wheat is worthless both for seed and milling, (3) wheat for seed should be thoroughly cleaned and tested as regards gluten and germinating power (*Minn. B. 11*). At the South Carolina Station (*B. 5*), Southern seed proved superior to the Northern. At the Kansas Station (*B. 20*) a mixture of several varieties of wheat sown together gave a heavier yield than single varieties. Seeding at a depth not exceeding two inches has generally given better results than deeper seeding (*Ala. Canebrake B. 5; Ill. B. 17; Ky. B. 21; Ohio B. vol. III, 6*).

The tests of drilling *vs.* broadcasting have given conflicting results, most frequently in favor of drilling. At the Kentucky Station, when the amount of seed used was from 0.5 to 1.25 bushels, drilling was best. When 1.25 to 2 bushels of seed were used, broadcasting gave the largest yield. (*Kans. B. 20, B. 33; Ky. B. 35; Ohio B. 42; S. Dak. B. 21.*)

Listing has been found in Kansas to materially increase the yield as compared with drilling in a dry year (*Kans. B. 11*), and to decrease the yield in a wet year (*B. 20*). At the Ohio Station five years' experience with a roller or wheel following in track of drill has been generally favorable to the practice.

Lois Weedon culture and mulching were failures at this station (*Ohio B. vol. III, 6*). Spring harrowing reduced the yield at the Kansas Station (*B. 20*), and at the South Carolina Station (*B. 7, n. ser.*). At the Kansas Station wheat has been grown continuously on the same land for ten years without decrease in yield (*Kans. B. 11*). At the Indiana Station (*B. 41*) the average gain for six years due to rotation was 6.1 bushels per acre. Pasturing young wheat reduced the yield (*Kans. B. 33*), as did mowing when the plants were about 6 inches high (*Ind. B. 41*).

Reports on other experiments in wheat culture may be found in the following publications: *Ark. B. 11, R. 1889, p. 19; Colo. R. 1890, p. 17; Kans. B. 7, R. 1888, p. 60; Ky. B. 11, B. 21, B. 30; Minn. R. 1888, p. 80; Ohio B. 1, R. 1882, p. 109, R. 1888, p. 50; S. Dak. B. 11.*

MANURING.—At the Pennsylvania and New Jersey Stations, little difference in yield resulted from the use of different forms of phosphoric acid (*N. J. R. 1890, p. 147; Pa. R. 1888, p. 124*). In South Carolina nitrogen, phosphoric acid, and potash combined gave the largest increase of yield on poor sandy land (*S. C. R. 1888, p. 156*). At the Maryland Station (*B. 14*) nitrogen gave the best results. At Kansas Station it was found that while the use of a moderate quantity of salt (300 pounds per acre) gave the straw a bright color the benefit from the use of this fertilizer was not very great, and that its use in large quantities might prove injurious. Salt has no effect in keeping off chinch bugs. In Kansas fertilizers in general do not materially increase the yield (*Kans. R. 1888, p. 71*). In Illinois (*B. 17*) and in Kentucky (*B. 35*) commercial fertilizers have given poor results on wheat.

At the Ohio Station commercial fertilizers have been unprofitable on wheat; but the yield on a plat which had grown *Melilotus alba* for three years was 26.9 bushels per acre against 18.6 bushels on an adjoining plat (*Ohio B. 42*). Similarly the stubble pea vines largely increased the yield of wheat at the North Carolina Station (*B. 77*).

(*Ark. R. 1888, p. 37; Conn. Storrs R. 1890, p. 37; Ky. B. 8, B. 11; Minn. B. 5, B. 23; N. J. B. 31, R. 1888, p. 101, R. 1890, p. 142; S. C. B. 4, n. ser., B. 7, R. 1889, p. 206, n. ser.*).

Wheat bran.—For composition, see *Appendix, Tables I and II.* For value as a feeding stuff, see accounts of experiments under *Gluten meal; Cotton-seed; Cotton-seed meal; Milk, effect of food upon; Cattle, feeding for beef and for growth,* and *Pigs.*

Wheat fly (*Oscinis variabilis?*).—A very small fly, somewhat resembling a small housefly. It is shining black with reddish brown eyes. The wings are slightly smoky with brown veins. The under side of the abdomen is pale green, the legs black and yellow. The female lays her eggs mostly in volunteer wheat, and late-sown wheat is not so liable to her attack. The worm is about one-eighth of an inch long, white with yellowish tinge. The body is made of thirteen segments.

Late sowing and destroying all volunteer growth will destroy many of the larvæ. Fertilizers should be added to the soil to stimulate a more vigorous growth of wheat capable of withstanding the attacks of this insect. (*Ky. B. 30; Ohio B. vol. V, 4.*)

Wheat, loose smut (*Ustilago tritici*).—A fungous disease very much resembling the smut of oats (*Ustilago avenæ*). The whole head is transformed into a black powdery mass of spores. Most authorities advise the same treatment of the seed before planting as for smut of oats and stinking smut of wheat, but some claim no advantage follows such treatment for this disease. (*Ind. B. 32; Kans. B. 22; Ky. B. 8; Nebr. B. 11; N. Dak. B. 1; Ohio B. vol. III, 6, B. vol. IV, 4; S. Dak. B. 17.*)

Wheat, rust (*Puccinia graminis*).—A well-known fungous disease, the attacks of which are usually worse during wet and hot seasons. When the conditions are favorable this fungus regularly passes through three phases in its life cycle. The first is upon the barberry leaves. Here in the spring it causes the cluster cups or barberry rust. The spores from this spread to the wheat fields, where they quickly develop and enter the tissues of the leaves. Its growth is kept up with the wheat, and about harvest time the second crop of spores is produced. These are the red-colored spores, which give it the name of red rust. Later there appear upon the "stubble," and sometimes upon the leaves, long black rows of spores. These are the spores of the third stage, and form the winter or resting stage of the fungus. Wherever there are no barberry bushes the first phase must be passed upon some other plant, or else the second phase is developed directly from the winter spores. Upon this point there is much yet to learn. Another species, *Puccinia rubigo-vera,* is thought to attack the young plant early in the fall from the old stubble and to spend the winter in the tissues of the host plant. This may be true also of the former species.

But little is yet known as to means of repression. Fungicides, where tried in an experimental way, have not given very satisfactory results. As one phase, the black rust, is confined almost entirely to the stubble, the burning of this after harvest would probably materially reduce the amount of fungus. Well-drained land is not as liable to severe loss from rust as that which is not drained. Some varieties of wheat are more susceptible to attacks than others, though none can be said to be rust-proof. As a rule, hard red wheats, especially those ripening early, have been found most resistant to the attacks of rust. (*Ind. B. 26; Iowa B. 10, B. 16; Kans. B. 21, B. 22; Mich. B. 83; Minn. B. 6, B. 11; N. C. B. 63.*)

Wheat sawfly (*Cephus pygmæus*).—The adult insect is one-third of an inch long of a shining black color, banded and spotted with yellow. The female is a little larger than the male. She deposits her eggs during the spring, usually about May, in the hollow part of the stem. The larvæ are from one-fifth to one-half inch long when mature, and of a yellowish white color. They usually tunnel through all the joints of the wheat stalks except the one next the ground. As the grain ripens the larvæ work toward the ground, and at harvest time most of them have penetrated nearly to the root. Here they make a cavity by cutting the straw nearly in two from within. They spend the winter in the stalk. When the grain is cut, the worms are left undisturbed in the stubble. In the spring they appear as adult flies. If abundant their cutting the stalks will cause the grain to fall and lodge. Burning the stubble and rotation of crops are recommended as remedies against this pest. (*N. Y. Cornell B. 11, R. 1888, p. 20; Ohio B. vol. V, 4.*)

Wheat scab (*Fusarium* [*Fusisporium*] *culmorum*).—A fungous disease which often affects the chaff and seed of wheat. Its presence is first indicated by the whitening of the upper part of the chaff, the lower remaining green. After a time the white part usually becomes pinkish and the chaff is stuck together as though glued. If the seed be examined it will be found shriveled and shrunken to about one-third its normal size and also of a pink color. The disease causes the heads to appear ripe before those not attacked. It seems to be worse upon late sown wheat and that which has not a very healthy growth.

Early sowing and the planting of early varieties are recommended as preventive measures. (*Del. R. 1890, p. 89; Ind. B. 36.*)

Wheat, stinking smut (*Tilletia fœtens*) [also called Bunt].—A fungous disease differing from loose smut in that only the individual grains are attacked and the whole head does not become a powdery mass.

Before the grain ripens the affected heads have a dark bluish green color. During the ripening of the grain these plants have a paler appearance than the healthy ones, and they never assume the yellowish color of ripened grain. If closely examined, the grains of wheat may be seen to be considerably swollen. If one of the swollen, smutted, grains is crushed, it will be found to be filled with a dark powder, which has a very disagreeable and penetrating odor. Often the disease is not recognized until the grain is threshed. Flour from diseased wheat is apt to be discolored and bad-smelling.

This disease can be prevented by soaking the seed in a solution of blue vitriol or by the Jensen hot-water method, as recommended for smut of oats (see *Oats, smut*). (*Ind. B. 32; Kans. B. 12, B. 21; Nebr. B. 11; N. Dak. B. 1; S. Dak. B. 17.*)

Whey.—It has been recently suggested to use whey in the preparation of a feeding cake for animals by mixing it with wheat bran, and also to use it for making vinegar and an alcoholic beverage. Milk sugar is commercially prepared from whey. For the value of whey for feeding pigs, see *Pigs*. For composition, see *Dairy products*.

Whitloof.—See *Chicory*.

White Malabar nightshade.—See *Basella*.

Willow trees (*Salix* spp.).—The willows, as rapid-growing and often hardy trees, enter frequently into the forestry studies of the Northern prairie stations, and have elsewhere been planted with a view to furnishing osiers. The white willow (*S. alba*), as noted in *S. Dak. B. 23*, "has been largely planted as a wind-break, for which purpose it is peculiarly fitted by reason of the great number of branches which extend from the ground along the entire stem. It is of rapid growth, especially in moist situations, and of easy culture. The timber is regarded as of rather more value than cottonwood. It does best in moist soils, but is successfully grown on uplands." It is not so well adapted for mixed planting as other species. In *Minn. B. 24* it is mentioned also as a well-known and most valuable tree, used for shelter belts and street planting, suitable for ornamental planting, lining water courses, and forming screens for more tender trees. It is subject to injury from the larva of the elm sawfly, a difficulty to be overcome by arsenical spraying.

Attention is called in an Iowa bulletin, 1885, to the importance of the red willow (*S. fragilis*) as the source of tanning material for the Russian upper leather, and as furnishing a lumber suitable for finishing, flooring, boat-building, etc. The same species was tested at the South Dakota Station as a nurse tree, for which it proved to be unfit, not growing in tree form. It would make an excellent wind-break or screen, but is infested with the cottonwood leaf beetle.

Russian willows are treated as a separate group. Of these, *S. acutifolia* is noted (*Iowa B. 1885*) as of greater timber value than the common willows, and capable of making a large tree on a dry soil and in a dry climate. It is described (*Minn. B. 24*) as "quite distinct in foliage and habit from other willows; very pretty and grace-

ful. Its leaves are glossy, branches slender, and covered with a blue bloom when more than one year old." The foliage is stated to resist the sawfly larva better than that of other willows. The laurel-leafed willow (*S. laurifolia*) is recommended for its beauty. "One of the finest and most satisfactory medium-sized trees we have, with large dark green leaves that shine as if varnished. Of close, pretty habit, it scarce resembles any of the common willows in appearance."

A Russian variety of the golden willow (*S. alba* var. *vitellina, S. vitellina* var.) is praised by both stations as specially fine. "Perfectly hardy and a very rapid grower, making a large tree. At all times a good tree, but especially handsome and conspicuous in the latter part of winter and toward spring, when the bark turns a bright golden yellow." Napoleon's willow (*S. napoleonis*), approved by both stations, is characterized in *Minn. B. 24* as "a pretty little spreading dwarf willow from Russia, with fine twigs and narrow bluish leaves; desirable for covering unsightly banks and for edging water courses." The royal willow (*S. regalis*) is another Russian species represented favorably for ornamental planting in *Minn. B. 24*. Forms of the weeping willow, Russian, or others, are mentioned in both places, one of which is the Wisconsin weeping willow. The rosemary willow (*S. rosmarinifolia*), a Russian shrub, is approved for planting on home grounds (*Iowa B. 16*). If top-worked on white or golden willow, "it forms a small tree with spreading top and pendulous habit that is very pleasing and peculiar." The Kilmarnock willow is found too tender for Minnesota (*B. 24*). Lists of osier willows from Austria received for trial from the U. S. Department of Agriculture occur in *Nebr. B. 19; N. C. B. 72; R. I. R. 1890, p. 162.*

Willow sawfly (*Cimbex americana*).—An insect which attacks willow, elm, and other trees, often defoliating them. It is the largest of our sawflies, the adult when flying resembling a bumblebee. The adults girdle the twigs with their powerful jaws to suck the sap. The eggs are laid in the leaves, the female making a depository for them near the edge of the leaf. When hatched the larvæ feed upon the leaves, until the supply is exhausted or the worm full grown. The full-grown worm is about 2 inches long, of a yellowish white color with a dark stripe along the back, usually more or less coiled, even when crawling from place to place. It spends the winter in the ground and emerges in the spring a full-fledged insect.

Handpicking, spraying with arsenites, and natural enemies are the means for preventing the rapid spread of the worms. (*Nebr. B. 5, B. 14; S. Dak. B. 22.*)

Wind-breaks.—One of the leading ends which the station work in forestry has sought to advance has been protection by timber growth from the effects of winds, a want particularly felt in the prairie States, but also where forests have been removed. This phase of forestry is particularly noted in *S. Dak. R. 1888, p. 27.* For a good wind-break it is advised to lay out a plat 48 rods long and 13 wide on the north side of the farmyards and sufficiently removed to permit the formation of snowdrifts between the trees and the buildings; adjoining this on the west end another plat 24 rods by 13 extending to the south. Directions are given for the culture of the trees, whether transplanted or seedlings. Evergreens in general, and above all the Scotch pine, are recommended for this purpose. Mixed planting is advised in *S. Dak. B. 23.* Some observed effects of trees in retaining snow are noted; directions are given for grove planting, close planting being advocated as against wide, and mixed planting as against the use of a single variety. *Tex. B. 8* contains collected data of trees preferred for wind-breaks in that State. The red cedar and varieties of arbor-vitæ were the favorites, though several others, as cottonwood, live oak, Calfornia privet, etc., had their advocates. See also *Mich. B. 45.* The use of wind-breaks for the protection of fruit trees has also been investigated by the stations. An article upon "Orchard Protection" occurs in *Minn. R. 1887–'88, p. 406,* in which the need of shelter from the summer sun as well as from the wind is considered. The case of a protected orchard is described, in which partial shade appeared to have been very beneficial, yet the benefit did not extend much further north than twice the height of the

wind-break; it seemed to be a mistake to set isolated evergreens in the midst of the orchard, a whole row being required for advantage. It is suggested that sun scald is due not only to the heat of the sun, but also to the low vitality of the tree. In *Mich. B. 32* is a brief discussion by Professor Bailey on the usefulness of wind-breaks for the fruit-grower, and in *N. Y. Cornell B. 9* the results of a thorough investigation of this subject by the same author, reviewing the returns from a circular inquiry to fruit-growers. The following conclusions are drawn: The benefits derived from wind-breaks include: Protection from cold; lessening of evaporation from soil and plants; lessening of liability to mechanical injury of trees; retention of snow and fallen leaves; facilitating of labor; protection of blossoms from severe winds; enabling trees to grow more erect, etc. Injuries sustained from wind-breaks are: Preventing the free circulation of warm winds and consequent exposure to cold; injuries from insects and fungous diseases; injuries from the encroachment of the wind-break itself; increased liability to late spring frosts in rare cases. Methods of avoiding the dangers are named, and it is concluded that "wind-breaks are advantageous wherever fruit plantations are exposed to strong winds." In interior places, dense or broad belts, of two or more rows of trees, are desirable, while within the influence of large bodies of water, thin or narrow belts, comprising but a row or two, are preferable.

The best trees for wind-breaks in the Northeastern States are Norway spruce and Austrian and Scotch pines, among the evergreens. Among deciduous trees, most of the rapidly growing native species are useful. A mixed plantation, with the hardiest and most vigorous deciduous trees on the windward, is probably the ideal artificial shelter belt. (See also *Wash. B. 3.*)

Wine.—Investigations on the fermentation, composition, and preservation of wine have been made by the California Station. As this work is very largely of a technical character, only a few of the more practical results will be mentioned here. The use of antiseptics in the conservation of wine is condemned. The keeping qualities of wines have been much improved by heating to 150° F. This treatment was generally successful for wine diseases, but in a few cases of tartaric and lactic fermentation it had no effect. Heating injured the flavor of the best class of wine.

Fermentation of wine in the absence of air resulted in a less complete extraction of the color and tannin of the grape than when air was admitted.

(Cal. Buls. 6, 9, 12, 13, 21, 23, 35, 37, 38, 40, 42, 43, 57, 60, 63, 65, 66, 67, 68, 69, 74, 77, 89, 91; R. 1888, p. 1, R. 1889, p. 44; Reports of Viticultural Work, 1881–'82, 1883–'84, 1885–'86, 1887–'89.)

Wireworms.—The larvæ of several species of click or snapping bugs. The adult insects are beetles, which make a clicking noise, and if placed upon their backs, leap into the air, falling upon their feet. The worms are hard, slender, six-legged, yellowish or brown larvæ of varying length, according to their age and species.

They are not to be confounded with other cylindrical worms having many legs. The wireworms have six jointed legs near the head and no more. They spend two or three years in the larval state in the ground and eat seeds or young roots of the planted crop. They seem to be worse in certain soils, especially peaty ones, and in recent sod ground. The subject of destroying wireworms by poison, starving, fertilizers, etc., has been thoroughly tested by Prof. J. H. Comstock (*N. Y. Cornell B. 33*), and he concludes that no direct treatment will affect the worms without destroying the crop in the ground. However, during the period of transition from larva to beetle, fall plowing, with thorough pulverizing, will destroy them. The adult beetles may be trapped and poisoned easily. Scatter about infested ground bunches of clover, which have been soaked in sweetened water to which Paris green has been added. Small balls of dough treated in the same way will do nearly as well. Rotation of crops will be found advantageous, as they are worse on some crops than on others. *(Iowa B. 5, B. 15; Ky. B. 40; N. J. B. 75; N. Y. Cornell B. 33, R. 1890, p. 39; Ore. B. 18; W. Va. R. 1890, p. 156.)*

Wisconsin Station, Madison.—Organized under State authority October 1, 1883, and reorganized under act of Congress in 1888 as a department of the University of Wisconsin. The staff consists of the president of the university, director, chemist, physicist, horticulturist, expert in animal husbandry, assistant chemist, dairyman, farm superintendent, and clerk and stenographer. The principal lines of work are chemistry; soils; field experiments with fertilizers, field crops, vegetables, and fruits; feeding experiments; and dairying. Up to January 1, 1893, the station had published 8 annual reports and 33 bulletins. Revenue in 1892, $15,000.

Wood ashes.—See *Ashes.*

Wool.—At the Wisconsin Station (*R. 1891, p. 23*) three wethers were shorn December 12, and a similar lot left unshorn till April 20, when both lots were shorn. The twice-shorn lot yielded a total of 28.5 pounds of unwashed wool, while the single shearing of the other lot afforded fleeces weighing 32.7 pounds. The wool of the first lot was shorter, and in washing lost 36 per cent of its weight; the wool of longer growth lost 44 per cent of its weight. See also *Sheep, shearing wethers in winter before fattening them.*

At the same station (*Wis. R. 1891, p. 14*) the wool produced by feeding a nitrogenous ration lost, in washing, 34 per cent of its weight, against a loss of only 29 per cent for the lot fed on a carbonaceous diet. See also *Sheep, feeding carbonaceous vs. nitrogenous rations.*

In one of the New York Cornell Station experiments a nitrogenous ration gave in one experiment (*N. Y. Cornell B. 8*) 72 per cent more wool and in another experiment (*N. Y. Cornell B. 2*) 55 per cent more than did a carbonaceous ration.

Wyoming Station, Laramie.—Organized under act of Congress January 10, 1891, as a department of the University of Wyoming. The staff consists of the president of the university and director, horticulturist, geologist and chemist, botanist, entomologist, assistant chemist, secretary, and superintendents of substations at Lander, Saratoga, Sheridan, Sundance, and Wheatland. The principal lines of work are botany; soils; field experiments with field crops, vegetables, and fruits; feeding experiments; entomology; and irrigation. Up to January 1, 1893, the station had published 1 annual report and 10 bulletins. Revenue in 1892, $15,156.

APPENDIX.

Table I gives the average composition of American feeding stuffs as compiled by Messrs. Jenkins and Winton, and published in Bulletin No. 11 of the Office of Experiment Stations. Tables II–V were compiled by Mr. W. H. Beal, of the Office of Experiment Stations, and present averages of American analyses, except where otherwise stated.

TABLE I.

AVERAGE COMPOSITION OF AMERICAN FEEDING STUFFS.

2094—No. 15——25

AVERAGE COMPOSITION OF AMERICAN

COMPILED AND CALCULATED BY E. H.

	Number of analyses.	In fresh or air-dry material.								
		Water.			Ash.			Protein (N×6.25).		
		Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
GREEN FODDER.										
CEREAL GRASSES:										
Corn (maize) fodder *a*—		%	%	%	%	%	%	%	%	%
Flint varieties	40	51.5	90.8	**79.8**	0.7	1.8	**1.1**	0.6	4.0	**2.0**
Flint varieties, cut after kernels had glazed	10*b*	69.7	83.7	**77.1**	0.9	1.7	**1.1**	1.5	2.7	**2.1**
Dent varieties	63	59.5	93.6	**79.0**	0.6	2.5	**1.2**	0.5	3.8	**1.7**
Dent varieties, cut after kernels had glazed	7	59.5	80.7	**73.4**	1.0	2.2	**1.5**	1.0	3.3	**2.0**
Sweet varieties	21	69.3	92.9	**79.1**	0.8	2.6	**1.3**	0.9	2.7	**1.9**
All varieties	123*c*	51.5	93.6	**79.3**	0.6	2.6	**1.2**	0.5	4.0	**1.8**
Leaves and husks, cut green	4	57.9	71.3	**66.2**	2.1	4.4	**2.9**	1.8	2.4	**2.1**
Stripped stalks, cut green	4	74.5	77.4	**76.1**	0.6	0.8	**0.7**	0.4	0.6	**0.5**
Sorghum, whole plant	11	63.9	86.4	**79.4**	0.7	2.3	**1.1**	0.9	2.6	**1.3**
Rye fodder	7	74.7	84.3	**76.6**	1.3	2.4	**1.8**	2.3	3.0	**2.6**
Oat fodder	5	31.3	78.6	**62.2**	1.5	4.2	**2.5**	1.5	6.1	**3.4**
OTHER GRASSES:										
Redtop *d* (*Agrostis vulgaris*) in bloom	5	57.3	76.2	**64.8**	1.7	2.8	**2.3**	2.0	4.3	**3.3**
Tall oat grass *e* (*Arrhenatherum avenaceum*) in bloom	3	62.3	73.5	**69.5**	1.6	3.0	**2.0**	1.7	3.3	**2.4**
Orchard grass (*Dactylis glomerata*) in bloom	4	66.9	77.3	**73.0**	1.6	2.9	**2.0**	1.9	4.1	**2.6**
Meadow fescue (*festuca pratensis*) in bloom	4	67.6	73.2	**69.9**	1.6	2.0	**1.8**	1.8	2.7	**2.4**
Timothy *f* (*Phleum pratense*)—										
All analyses	56	47.0	78.7	**61.6**	1.4	3.2	**2.1**	1.3	3.8	**3.1**
Before bloom, headed	3	61.7	78.6	**69.3**	1.8	1.8	**2.3**	3.0	3.6	**3.4**
In full bloom	14	57.3	71.9	**65.1**	1.4	2.5	**2.0**	1.3	3.7	**2.8**
Just after bloom	5	56.3	65.2	**59.4**	1.7	2.9	**2.3**	2.0	3.8	**2.9**
In seed, nearly ripe	4	53.0	77.8	**62.3**	1.6	2.8	**2.2**	2.0	3.0	**2.5**
Kentucky blue grass *g* (*Poa pratensis*)—										
All analyses	18	51.7	82.5	**65.1**	1.6	4.8	**2.8**	2.4	7.2	**4.1**
Before bloom, headed	3	59.9	70.8	**64.7**	1.6	3.7	**2.8**	4.1	7.2	**5.3**
In bloom	5	62.9	75.7	**69.1**	1.6	3.1	**2.4**	2.4	3.6	**3.2**
Past bloom and in seed	4	51.7	55.9	**54.4**	2.8	4.8	**3.4**	3.3	5.5	**4.2**
LEGUMES:										
Red clover (*Trifolium pratense*)—										
All analyses	43	47.1	91.8	**70.8**	0.9	4.0	**2.1**	1.7	7.1	**4.4**
Before bloom	2	61.2	82.7	**72.0**	1.5	3.2	**2.4**	4.4	5.5	**5.0**
In bloom	5	47.1	91.8	**72.7**	0.9	4.0	**2.2**	1.7	7.1	**4.3**
After bloom and in seed	4	61.1	71.2	**68.2**	1.9	2.5	**2.2**	4.0	5.5	**4.5**
Alsike clover *h* (*Trifolium hybridum*) in bloom	4	72.3	77.3	**74.8**	1.9	2.1	**2.0**	3.6	4.2	**3.9**
Alfalfa *i* (*Medicago sativa*)—										
All analyses	23	49.3	82.0	**71.8**	1.8	5.1	**2.7**	3.5	7.7	**4.8**
Cowpea (*Dolichos*)	10	72.8	93.1	**83.6**	1.2	2.7	**1.7**	1.5	3.5	**2.4**
Soja bean (*Soja hispida*)	6	69.4	81.2	**74.8**	2.2	2.6	**2.4**	2.2	3.9	**3.0**
SILAGE.										
Corn (maize) silage	99	62.4	87.7	**79.1**	0.3	3.3	**1.4**	0.7	3.6	**1.7**
Corn (maize) kernels, ensiled	9	21.1	54.4	**41.3**	0.6	1.7	**1.0**	4.6	10.1	**6.0**
Sorghum silage	6	71.9	78.0	**76.1**	0.8	1.2	**1.1**	0.6	0.9	**0.8**
Brewers' grain silage	3	66.8	73.9	**69.8**	1.0	1.4	**1.2**	5.9	7.1	**6.6**
Red clover silage	5	61.4	78.6	**72.0**	1.9	3.0	**2.6**	3.0	5.9	**4.2**

a Corn fodder is the entire plant, usually a thickly planted crop. Corn stover is what is left after the ears are harvested.

b Included in the analyses immediately preceding.

c Including two unclassified varieties.

d Herd's grass of Pennsylvania.

e Meadow oat grass.

f Herd's grass of New England and New York.

g June grass.

h Swedish clover.

i Lucern.

FEEDING STUFFS, WITH MAXIMA AND MINIMA.

JENKINS AND A. L. WINTON.

In fresh or air-dry material.									Calculated to water-free substance.				
Fiber.			Nitrogen-free extract.			Fat.			Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Average.	Average.	Average.	Average.	Average.
%	%	%	%	%	%	%	%	%	%	%	%	%	%
2.1	11.4	4.3	4.3	36.3	12.1	0.3	1.3	0.7	5.2	9.7	21.3	60.6	3.2
3.0	6.1	4.3	10.0	19.7	14.6	0.6	1.3	0.8	5.0	9.2	18.9	63.2	3.7
2.0	11.0	5.6	3.0	27.0	12.0	0.1	1.6	0.5	5.7	8.3	26.3	57.1	2.6
5.4	8.5	6.7	11.6	27.0	15.5	0.4	1.6	0.9	5.4	7.5	25.2	58.7	3.2
1.9	8.5	4.4	3.2	19.4	12.8	0.1	1.0	0.5	6.0	8.9	21.2	61.7	2.2
1.9	11.4	5.0	3.0	36.3	12.2	0.1	1.6	0.5	5.6	8.8	24.1	58.9	2.6
6.6	12.5	8.7	16.7	22.2	19.0	1.0	1.3	1.1	8.5	6.2	25.7	56.4	3.2
6.7	8.8	7.3	14.2	16.0	14.9	0.4	0.6	0.5	2.9	2.3	30.7	62.0	2.1
4.7	9.1	6.1	5.3	21.5	11.6	0.2	1.1	0.5	5.3	6.5	29.7	56.2	2.3
4.7	14.9	11.6	4.9	12.4	6.8	0.2	0.7	0.6	7.7	11.1	49.5	29.2	2.5
7.1	16.8	11.2	10.8	39.8	19.3	0.4	3.0	1.4	6.6	9.1	29.5	51.1	3.7
6.5	15.7	9.4	11.7	24.1	19.1	0.6	2.2	1.2	6.6	9.4	26.8	53.9	3.3
9.2	9.7	9.4	13.0	20.7	15.8	0.6	1.5	0.9	6.7	7.8	30.7	51.8	3.0
5.8	11.1	8.2	9.9	16.6	13.3	0.7	1.3	0.9	7.4	9.6	30.4	49.3	3.3
10.2	11.3	10.8	12.5	15.7	14.3	0.7	1.1	0.8	6.0	8.0	35.7	47.5	2.8
5.1	19.4	11.8	10.1	28.6	20.2	0.6	2.0	1.2	5.4	8.0	30.7	52.8	3.1
5.1	12.7	8.3	10.1	19.4	15.7	0.8	1.3	1.1	7.7	11.3	26.3	50.9	3.8
6.4	13.9	10.4	13.9	22.4	18.7	0.7	1.5	1.0	5.7	7.9	29.9	53.6	2.9
11.1	13.7	12.6	18.0	23.6	21.5	0.9	2.0	1.3	5.7	7.1	30.9	53.2	3.1
5.1	15.8	11.5	11.3	28.6	20.4	0.8	1.8	1.1	5.7	6.6	30.7	54.2	2.8
3.8	14.8	9.1	6.5	26.6	17.6	0.8	1.9	1.3	8.0	11.8	26.2	50.3	3.7
6.7	12.8	9.5	14.9	19.0	16.3	1.2	1.6	1.4	8.0	15.1	26.8	46.1	4.0
6.7	10.8	8.3	11.2	18.7	16.1	0.8	1.2	0.9	7.7	10.3	26.7	52.3	3.0
10.6	14.8	11.8	23.2	26.6	24.5	1.5	1.9	1.7	7.5	9.1	25.8	53.9	3.7
1.8	14.7	8.1	3.5	25.8	13.5	0.3	1.8	1.1	7.2	15.3	27.8	45.8	3.9
2.3	10.8	6.5	8.1	18.6	13.3	0.7	1.0	0.8	8.6	17.8	23.2	47.5	2.9
1.8	14.7	6.5	3.5	25.8	13.4	0.3	1.3	0.9	8.1	15.7	23.8	49.2	3.2
5.0	12.4	7.2	12.9	20.2	16.7	0.9	1.7	1.2	6.9	14.2	22.6	52.5	3.8
5.3	9.4	7.4	10.8	11.5	11.0	0.6	1.2	0.9	7.8	15.3	29.2	44.0	3.7
2.5	14.8	7.4	7.9	26.2	12.3	0.5	2.2	1.0	9.4	17.1	26.2	43.9	3.4
1.7	15.3	4.8	1.8	12.9	7.1	0.2	0.6	0.4	10.5	14.3	29.0	43.6	2.6
5.6	8.9	7.3	5.8	16.0	11.5	0.7	1.5	1.0	9.5	12.0	29.0	45.7	3.8
3.0	10.5	6.0	5.1	24.2	11.1	0.2	2.0	0.8	6.6	8.0	28.7	53.0	3.8*
0.8	3.7	1.5	35.7	59.1	46.6	2.8	4.4	3.6	1.7	10.2	2.6	79.4	6.1
5.9	6.8	6.4	13.8	19.0	15.3	0.1	0.5	0.3	4.4	3.3	26.8	64.2	1.3
3.9	5.4	4.7	13.7	16.9	15.6	1.8	2.6	2.1	4.0	22.0	15.4	51.7	7.0
5.1	13.9	8.4	8.1	14.3	11.6	0.9	1.6	1.2	9.3	14.9	29.9	41.7	4.1

AVERAGE COMPOSITION OF AMERICAN FEEDING

	No. of analyses.	In fresh or air-dry material.								
		Water.			Ash.			Protein (N×6.25).		
		Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
HAY AND DRY COARSE FODDER.		%	%	%	%	%	%	%	%	%
Corn (maize) fodder, field-cured	35	22.9	60.2	**42.2**	1.5	5.5	**2.7**	2.7	6.8	**4.5**
Corn (maize) leaves, field-cured	17	14.8	44.0	**30.0**	4.3	7.4	**5.5**	4.5	8.3	**6.0**
Corn (maize) husks, field-cured	16	26.7	76.6	**50.9**	0.6	2.3	**1.8**	1.3	3.2	**2.5**
Corn (maize) stalks, field-cured	15	51.3	78.5	**68.4**	0.6	2.0	**1.2**	1.2	3.0	**1.9**
Corn (maize) stover, field-cured	60	15.4	57.4	**40.1**	1.7	7.0	**3.4**	1.8	8.3	**3.8**
Hay from grasses named:										
Couch grass *a* (*Agropyrum repens*)	5	6.3	14.3	**14.3**	4.8	8.0	**6.0**	8.5	10.8	**8.8**
Redtop (*Agrostis vulgaris*)—										
All analyses	9	6.8	11.6	**8.9**	3.8	7.0	**5.2**	5.9	10.4	**7.9**
Cut in bloom	3	6.8	11.6	**8.7**	4.8	6.5	**4.9**	7.8	10.4	**8.0**
Orchard grass (*Dactylis glomerata*)	10	6.5	13.6	**9.9**	5.0	7.9	**6.0**	6.6	10.4	**8.1**
Timothy (*Phleum pratense*)—										
All analyses	68	6.1	28.9	**13.2**	2.5	6.3	**4.4**	3.8	9.7	**5.9**
Cut in full bloom	12	7.0	28.9	**15.0**	2.5	6.0	**4.5**	5.0	7.5	**6.0**
Cut soon after bloom	11	7.8	21.6	**14.2**	3.5	5.4	**4.4**	4.6	8.1	**5.7**
Cut when nearly ripe	12	7.0	22.7	**14.1**	2.7	5.1	**3.9**	4.3	6.0	**5.0**
Hungarian grass (*Setaria italica*)	12	4.9	9.5	**7.7**	5.0	7.5	**6.0**	4.7	12.3	**7.5**
Creek sedge (*Spartina stricta*, var. *glabra*)	5	7.4	9.7	**8.3**	8.3	15.3	**10.7**	4.0	8.4	**6.6**
Hay from legumes named:										
Red clover (*Trifolium pratense*)—										
All analyses	38	6.0	31.3	**15.3**	3.9	8.3	**6.2**	10.0	20.8	**12.3**
In bloom	6	6.0	31.3	**20.8**	5.6	8.3	**6.6**	10.8	15.4	**12.4**
Red clover (*Trifolium medium*)—										
All analyses	10	7.3	29.4	**21.2**	4.5	9.5	**6.1**	9.0	16.8	**10.7**
In bloom	5	9.4	26.7	**20.9**	4.5	9.5	**6.6**	9.0	16.8	**11.5**
Alsike clover (*Trifolium hybridum*)	9	5.3	13.9	**9.7**	6.1	12.2	**8.3**	9.2	16.1	**12.8**
White clover (*Trifolium repens*)	7	6.1	13.5	**9.7**	4.5	13.8	**8.3**	13.9	20.0	**15.7**
Alfalfa (*Medicago sativa*)	21	4.6	16.0	**8.4**	3.1	10.4	**7.4**	10.2	20.3	**14.3**
Cowpea (*Dolichos*)	8	7.6	14.0	**10.7**	3.2	10.2	**7.5**	13.6	20.3	**16.6**
Black grass (*Juncus gerardi*)	20	6.7	13.2	**9.5**	4.9	9.2	**7.0**	5.3	11.6	**7.5**
Wheat straw	7	6.5	17.9	**9.6**	3.0	7.0	**4.2**	2.9	5.0	**3.4**
Rye straw	7	6.3	9.7	**7.1**	2.8	3.4	**3.2**	2.2	3.6	**3.0**
Oat straw	12	6.5	18.3	**9.2**	3.7	6.7	**5.1**	2.7	6.9	**4.0**
Buckwheat straw	3	9.0	10.4	**9.9**	4.9	6.5	**5.5**	3.3	7.8	**5.2**
ROOTS, BULBS, TUBERS, AND OTHER VEGETABLES.										
Potatoes	12	75.4	82.2	**78.9**	0.8	1.2	**1.0**	1.1	3.0	**2.1**
Sweet potatoes	6	66.0	74.4	**71.1**	0.7	1.3	**1.0**	0.5	3.6	**1.5**
Red beets	9	85.5	92.2	**88.5**	0.7	1.4	**1.0**	1.1	1.8	**1.5**
Sugar beets	19	80.5	90.8	**86.5**	0.4	1.4	**0.9**	1.1	3.2	**1.8**
Mangel-wurzels	9	86.9	94.4	**90.9**	0.8	1.4	**1.1**	1.0	1.9	**1.4**
Turnips	3	87.2	92.4	**90.5**	0.7	1.0	**0.8**	0.8	1.4	**1.1**
Ruta-bagas	4	87.1	91.8	**88.6**	1.0	1.4	**1.2**	1.0	1.3	**1.2**
Carrots	8	86.5	91.1	**88.6**	0.6	1.3	**1.0**	0.8	2.0	**1.1**
Onions	6	81.5	93.5	**87.6**	0.4	0.7	**0.6**	0.8	2.3	**1.4**
Cucumbers	2	95.7	96.3	**96.0**	0.5	0.5	**0.5**	0.8	0.8	**0.8**
Cabbage	2	87.5	93.6	**90.5**	0.7	2.1	**1.4**	2.1	2.7	**2.4**
Asparagus	3	93.6	94.3	**94.0**	0.5	1.0	**0.7**	1.6	2.1	**1.8**
Strawberries	19	87.7	94.0	**90.8**	0.4	0.8	**0.6**	0.6	1.2	**1.0**
Lemons	2	88.4	90.2	**89.3**	0.5	0.5	**0.5**	0.8	1.1	**1.0**
GRAINS AND OTHER SEEDS.										
Corn (maize) kernel—										
Dent, raised in Connecticut	9	9.6	15.2	**10.8**	1.2	1.8	**1.5**	8.3	11.6	**10.1**
Dent, raised in Kansas	6	11.4	12.3	**11.9**	1.3	1.7	**1.5**	9.1	10.7	**10.2**

a Corn fodder is the entire plant, usually a thickly planted crop; corn stover is what is left after the ears are harvested.

STUFFS, WITH MAXIMA AND MINIMA—Continued.

In fresh or air-dry material.									Calculated to water-free substance.				
Crude fiber.			Nitrogen-free extract.			Fat.			Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Average.	Average.	Average.	Average.	Average.
%	%	%	%	%	%	%	%	%	%	%	%	%	%
7.5	24.7	**14.3**	20.6	47.8	**34.7**	0.6	2.5	**1.6**	4.7	7.8	24.7	60.1	2.8
17.4	27.4	**21.4**	27.3	44.1	**35.7**	0.8	2.2	**1.4**	7.9	8.6	30.6	51.0	1.9
6.8	23.6	**15.8**	14.3	43.6	**28.3**	0.5	1.0	**0.7**	3.5	5.0	32.2	57.9	1.4
6.9	16.8	**11.0**	11.2	26.0	**17.0**	0.3	1.0	**0.5**	3.6	5.9	34.8	54.1	1.6
14.1	32.2	**19.7**	23.3	53.3	**31.9**	0.7	2.2	**1.1**	5.7	6.4	33.0	53.2	1.7
16.6	34.5	**24.8**	38.5	49.5	**43.1**	2.9	3.4	**3.0**	7.0	10.3	29.1	50.2	3.5
24.0	31.8	**28.6**	44.8	50.4	**47.4**	1.4	3.2	**1.9**	5.7	8.7	31.4	52.1	2.1
24.0	31.8	**29.9**	46.8	47.8	**46.4**	1.5	2.3	**2.1**	5.4	8.7	32.8	50.8	2.3
28.9	38.3	**32.4**	32.9	48.6	**41.0**	1.7	3.3	**2.6**	6.7	9.0	36.0	45.4	2.9
22.2	38.5	**29.0**	34.3	58.5	**45.0**	1.0	4.0	**2.5**	5.1	6.8	33.5	51.7	2.9
22.2	37.1	**29.6**	34.3	48.5	**41.9**	2.0	4.0	**3.0**	5.3	7.1	34.7	49.4	3.5
25.7	33.4	**28.1**	37.0	51.0	**44.6**	1.9	3.6	**3.0**	5.1	6.6	32.7	52.1	3.5
24.8	38.5	**31.1**	38.0	49.1	**43.7**	1.0	2.8	**2.2**	4.5	5.8	36.2	50.9	2.6
23.6	31.3	**27.7**	44.4	53.0	**49.0**	1.5	3.5	**2.1**	6.5	8.1	30.0	53.1	2.3
25.5	27.7	**26.9**	39.0	51.3	**45.4**	1.8	2.2	**2.1**	11.6	7.1	29.3	49.7	2.3
15.6	35.7	**24.8**	27.3	52.2	**38.1**	1.5	5.9	**3.3**	7.3	14.5	29.1	45.2	3.9
17.9	28.1	**21.9**	27.3	41.3	**33.8**	2.5	5.9	**4.5**	8.3	15.6	27.5	43.0	5.6
18.3	29.4	**24.5**	28.6	44.4	**33.6**	1.6	5.3	**3.9**	7.3	13.5	31.3	43.0	4.9
18.3	27.8	**24.7**	28.6	44.4	**33.0**	1.6	5.1	**3.3**	8.2	14.6	31.1	41.9	4.2
19.7	29.5	**25.6**	35.6	45.9	**40.7**	1.6	4.2	**2.9**	9.3	14.2	28.4	44.9	3.2
20.3	30.3	**24.1**	33.4	47.3	**39.3**	1.7	5.8	**2.9**	9.2	17.4	26.7	43.5	3.2
14.0	33.0	**25.0**	35.1	53.6	**42.7**	1.1	3.8	**2.2**	8.1	15.6	27.3	46.6	2.4
16.4	26.0	**20.1**	39.4	49.5	**42.2**	1.1	3.7	**2.9**	8.5	18.6	22.5	47.2	3.2
20.4	35.9	**25.9**	42.6	53.4	**47.7**	1.1	3.2	**2.4**	7.6	8.2	28.5	53.0	2.7
34.3	42.7	**38.1**	31.0	50.6	**43.4**	0.8	1.8	**1.3**	4.6	3.8	42.1	48.1	1.4
32.7	43.3	**38.9**	41.0	52.9	**46.6**	1.0	1.6	**1.2**	3.4	3.2	41.9	50.2	1.3
31.8	45.1	**37.0**	33.5	51.4	**42.4**	1.7	3.2	**2.3**	5.6	4.4	40.7	46.8	2.5
37.2	46.8	**43.0**	32.1	38.9	**35.1**	0.7	1.7	**1.3**	6.1	5.8	47.7	39.0	1.4
0.3	0.9	**0.6**	14.1	29.4	**17.3**	0.0	0.1	**0.1**	4.5	10.1	2.7	82.2	0.5
0.6	2.5	**1.3**	18.0	29.7	**24.7**	0.3	0.6	**0.4**	3.5	5.2	3.6	86.3	1.4
0.6	1.7	**0.9**	3.8	11.3	**8.0**	0.1	0.2	**0.1**	9.1	13.4	7.8	68.4	1.3
0.6	1.3	**0.9**	5.7	13.6	**9.8**	0.1	0.2	**0.1**	6.5	13.0	6.5	73.3	0.7
0.6	1.3	**0.9**	2.4	8.7	**5.5**	0.1	0.5	**0.2**	11.5	15.2	9.5	62.0	1.8
0.8	1.4	**1.2**	4.2	8.8	**6.2**	0.1	0.2	**0.2**	8.4	12.4	12.2	64.9	2.1
1.1	1.4	**1.3**	5.1	9.1	**7.5**	0.1	0.3	**0.2**	10.1	10.4	11.0	66.8	1.3
0.9	2.3	**1.3**	5.1	10.4	**7.6**	0.2	0.7	**0.4**	8.8	10.0	11.2	66.3	3.7
0.6	0.8	**0.7**	3.8	14.7	**9.4**	0.2	0.4	**0.3**	4.5	11.3	5.5	76.5	2.2
0.5	0.9	**0.7**	1.7	2.0	**1.8**	0.2	0.2	**0.2**	11.5	20.3	17.3	45.4	5.5
1.4	1.5	**1.5**	2.0	5.7	**3.9**	0.2	0.5	**0.4**	14.8	25.1	15.5	40.7	3.9
0.7	0.8	**0.7**	2.3	2.9	**2.5**	0.2	0.3	**0.3**	11.1	30.2	12.2	42.3	4.2
0.7	2.3	**1.4**	3.7	6.4	**5.5**	0.4	1.1	**0.7**	6.5	10.4	15.6	60.1	7.4
0.9	1.3	**1.1**	6.9	7.6	**7.2**	0.2	1.6	**0.9**	4.7	8.8	10.1	67.9	8.5
1.3	2.2	**1.7**	69.8	73.4	**71.3**	3.8	5.2	**4.4**	1.7	11.3	1.8	80.1	5.0
1.7	2.7	**2.2**	68.4	71.7	**69.3**	4.5	5.7	**4.9**	1.7	11.6	2.5	78.6	5.6

AVERAGE COMPOSITION OF AMERICAN FEEDING

	Number of analyses.	In fresh or air-dry material.								
		Water.			Ash.			Protein (N×6.25).		
		Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
GRAINS AND OTHER SEEDS—Continued.										
Corn (maize) kernel—continued.		%	%	%	%	%	%	%	%	%
Dent, raised in Michigan	7	11.7	14.1	**13.1**	1.3	1.6	**1.4**	9.9	11.8	**11.0**
Dent, raised in Missouri	22	7.4	9.1	**8.2**	1.3	2.1	**1.7**	8.2	12.8	**10.5**
Dent, raised in Texas	19	9.3	12.1	**10.6**	1.0	1.7	**1.4**	9.8	11.0	**10.4**
Dent, raised in Wisconsin	5	13.7	19.4	**17.0**	1.3	2.6	**1.7**	8.7	10.3	**9.4**
Dent, all analyses	86	6.2	19.4	**10.6**	1.0	2.6	**1.5**	7.5	12.8	**10.3**
Flint, raised in Connecticut	11	8.7	18.2	**14.2**	1.0	1.6	**1.3**	8.9	11.6	**10.1**
Flint, raised in Massachusetts	12	8.9	14.4	**11.1**	1.1	1.6	**1.4**	7.9	12.9	**11.1**
Flint, raised in Michigan	4	12.9	13.5	**13.2**	1.4	1.5	**1.5**	10.7	12.0	**11.5**
Flint, raised in New Hampshire	11	8.3	11.5	**10.1**	1.3	1.8	**1.5**	10.5	13.7	**11.6**
Flint, all analyses	68	4.5	19.6	**11.3**	1.0	1.9	**1.4**	7.0	13.7	**10.5**
Sweet, raised in Massachusetts	6	6.3	10.9	**8.7**	1.6	1.9	**1.8**	11.6	14.4	**12.8**
Sweet, raised in Pennsylvania	8	7.0	9.5	**8.0**	1.7	2.4	**2.0**	9.5	11.7	**10.7**
Sweet, all analyses	26	6.0	10.9	**8.8**	1.4	2.4	**1.9**	9.5	15.3	**11.6**
Pop varieties	4	8.6	12.6	**10.7**	1.2	1.7	**1.5**	9.7	13.1	**11.2**
Soft varieties	5	6.1	14.1	**9.3**	1.4	1.9	**1.6**	8.8	14.6	**11.4**
All varieties and analyses	208	4.5	20.7	**10.9**	1.0	2.6	**1.5**	7.0	15.3	**10.5**
Field-cured, dent varieties	17	28.8	39.3	**34.2**	0.7	1.3	**0.9**	4.4	8.3	**6.3**
Small and from immature ears	9	31.2	57.5	**38.9**	0.7	1.2	**0.9**	5.4	8.6	**6.8**
Field-cured, flint varieties	48	22.0	32.1	**27.1**	0.6	1.6	**1.3**	5.6	10.6	**8.0**
Small and from immature ears	7	24.0	74.8	**34.5**	0.4	1.0	**0.8**	3.3	10.3	**7.9**
Sorghum seed	10	9.3	16.8	**12.8**	1.4	4.3	**2.1**	7.7	11.3	**9.1**
Barley	10	7.2	12.6	**10.9**	1.8	3.2	**2.4**	8.6	15.7	**12.4**
Oats	30	8.9	13.5	**11.0**	2.0	3.6	**3.0**	8.0	14.4	**11.8**
Rye	6	8.7	13.2	**11.6**	1.8	1.9	**1.9**	9.5	12.1	**10.6**
Wheat, spring varieties	13	8.1	13.4	**10.4**	1.5	2.6	**1.9**	8.1	15.4	**12.5**
Wheat, winter varieties, raised in—										
Alabama	17	9.4	12.4	**10.9**	1.8	2.4	**2.0**	9.8	13.7	**11.4**
California	4	10.7	11.2	**11.0**	1.5	2.0	**1.8**	8.3	13.8	**11.1**
Colorado	50	7.9	10.6	**9.6**	1.8	3.6	**2.2**	11.2	15.9	**13.3**
Georgia	8	8.0	12.2	**9.9**	1.6	2.3	**1.9**	9.5	14.0	**11.6**
Indiana	8	9.9	12.4	**10.8**	1.4	2.1	**1.8**	11.9	14.5	**13.2**
Maryland	9	8.4	11.9	**10.5**	1.4	2.2	**1.8**	9.8	14.5	**11.7**
Michigan	23	9.1	13.8	**10.8**	1.0	2.1	**1.7**	9.1	15.2	**11.6**
Missouri	12	7.7	13.5	**9.8**	1.6	2.2	**1.9**	10.5	14.0	**11.6**
New Jersey	13	13.3	14.0	**13.7**	1.8	2.2	**2.0**	9.2	12.5	**10.3**
North Carolina	22	8.2	11.7	**10.0**	1.2	1.9	**1.6**	8.9	12.4	**10.4**
Oregon	5	9.0	13.0	**9.9**	1.5	2.0	**1.7**	8.1	10.6	**8.6**
Pennsylvania	41	7.6	13.3	**10.7**	0.8	3.0	**1.6**	9.5	15.6	**11.8**
Tennessee	14	7.1	11.9	**10.2**	1.6	2.4	**1.9**	10.0	16.6	**12.5**
Virginia	11	8.8	12.3	**10.3**	1.1	2.5	**1.7**	10.2	14.0	**12.2**
Wheat, winter varieties, all analyses	262	7.1	14.0	**10.5**	0.8	3.6	**1.8**	8.1	16.6	**11.8**
Wheat, all complete analyses of all varieties	310	7.1	14.0	**10.5**	0.8	3.6	**1.8**	8.1	17.2	**11.9**
Rice	10	11.4	14.0	**12.4**	0.3	0.5	**0.4**	5.9	8.6	**7.4**
Buckwheat	8	10.9	14.8	**12.6**	1.6	2.3	**2.0**	8.6	11.0	**10.0**
Soja bean	8	5.9	19.3	**10.8**	3.1	5.4	**4.7**	26.3	40.2	**34.0**
Cowpea	5	10.0	20.9	**14.8**	2.9	3.4	**3.2**	19.3	23.0	**20.8**
MILL PRODUCTS.										
Corn (maize) meal	77	8.0	27.4	**15.0**	0.9	4.1	**1.4**	7.1	13.9	**9.2**
Corn-and-cob meal	7	9.5	26.3	**15.1**	1.2	1.9	**1.5**	5.8	12.2	**8.5**
Oatmeal	6	6.2	8.8	**7.9**	1.8	2.2	**2.0**	12.9	16.3	**14.7**
Barley meal	3	9.9	13.6	**11.9**	1.6	3.8	**2.6**	9.8	12.7	**10.5**
Rye flour	4	12.4	13.6	**13.1**	0.6	0.8	**0.7**	6.0	6.9	**6.7**
Wheat flour, all analyses	20	8.2	13.6	**12.4**	0.3	0.7	**0.5**	8.6	13.6	**10.8**
Graham flour	3	12.1	13.7	**13.1**	1.7	2.0	**1.8**	11.2	12.4	**11.7**
Buckwheat flour	4	12.8	17.6	**14.6**	0.7	1.3	**1.0**	4.2	8.1	**6.9**

STUFFS, WITH MAXIMA AND MINIMA—Continued.

In fresh or air-dry material.									Calculated to water-free substance.				
Crude fiber.			Nitrogen-free extract.			Fat.			Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Average.	Average.	Average.	Average.	Average.
%	%	%	%	%	%	%	%	%	%	%	%	%	%
2.0	2.5	**2.3**	66.3	69.1	**67.4**	4.6	5.0	**4.8**	1.6	12.6	2.6	77.7	5.5
1.4	3.1	**2.4**	69.8	74.8	**71.8**	4.3	7.5	**5.4**	1.9	11.4	2.6	78.2	5.9
1.8	4.8	**2.8**	66.7	71.4	**69.3**	5.0	6.6	**5.5**	1.6	11.6	3.1	77.6	6.1
1.3	2.9	**1.8**	65.4	68.1	**66.3**	3.1	4.3	**3.8**	2.9	11.3	2.1	79.1	4.6
0.9	4.8	**2.2**	65.4	75.7	**70.4**	3.1	7.5	**5.0**	1.7	11.5	2.6	78.6	5.6
0.8	1.5	**1.2**	65.0	72.3	**68.6**	3.9	5.7	**4.6**	1.5	11.8	1.3	80.0	5.4
1.1	2.5	**1.9**	66.5	74.2	**69.8**	3.4	5.9	**4.7**	1.6	12.4	2.1	78.6	5.3
2.0	2.5	**2.2**	66.0	67.4	**66.6**	4.8	5.1	**5.0**	1.7	13.2	2.5	76.8	5.8
0.8	1.3	**1.1**	67.6	73.3	**70.2**	4.7	7.1	**5.5**	1.7	12.8	1.2	78.2	6.1
0.7	2.9	**1.7**	65.0	76.7	**70.1**	3.4	7.1	**5.0**	1.7	11.8	1.9	79.0	5.6
1.6	2.6	**2.1**	65.5	68.9	**67.0**	3.8	9.2	**7.6**	2.0	14.0	2.3	73.4	8.3
3.0	5.2	**3.7**	62.5	69.1	**66.6**	7.8	11.9	**9.0**	2.2	11.6	4.0	72.4	9.8
1.5	5.2	**2.8**	61.8	72.4	**66.8**	3.8	11.9	**8.1**	2.1	12.8	3.1	73.2	8.8
1.2	2.3	**1.8**	68.4	71.1	**69.6**	4.2	6.0	**5.2**	1.7	12.5	2.0	78.0	5.8
1.3	3.3	**2.0**	66.0	75.5	**70.2**	5.0	5.7	**5.5**	1.8	12.5	2.2	77.4	6.1
0.7	5.2	**2.1**	61.8	76.7	**69.6**	3.1	11.9	**5.4**	1.7	11.7	2.4	78.1	6.1
0.9	1.8	**1.2**	50.3	59.4	**53.9**	2.9	4.0	**3.5**	1.3	9.6	1.8	81.9	5.4
0.9	1.1	**1.1**	33.5	54.1	**49.0**	1.8	4.3	**3.4**	1.5	11.1	2.0	80.0	5.4
0.7	1.6	**1.8**	53.9	64.4	**58.1**	3.4	5.3	**4.2**	1.7	10.9	1.8	79.8	5.8
0.3	1.0	**0.8**	19.9	62.5	**52.4**	1.4	3.0	**3.6**	1.3	11.9	1.2	80.6	5.0
1.5	8.7	**2.6**	59.0	73.6	**70.0**	2.1	4.6	**3.6**	2.4	10.4	3.0	80.1	4.1
1.3	4.2	**2.7**	66.7	73.9	**69.8**	1.5	3.2	**1.8**	2.7	13.9	3.0	78.4	2.0
1.5	12.9	**9.5**	53.5	66.9	**59.7**	3.4	5.8	**5.0**	3.4	13.2	10.8	67.0	5.6
1.4	2.1	**1.7**	71.2	73.9	**72.5**	1.4	2.1	**1.7**	2.1	12.0	1.9	82.2	1.9
1.3	2.3	**1.8**	66.1	78.7	**71.2**	1.8	2.6	**2.2**	2.1	13.9	2.0	79.5	2.5
1.3	1.9	**1.6**	68.5	74.4	**71.8**	1.6	2.7	**2.2**	2.2	12.8	1.8	80.7	2.5
1.8	2.2	**2.0**	70.2	74.8	**72.5**	1.5	1.8	**1.6**	2.0	12.5	2.2	81.5	1.8
1.1	2.2	**1.6**	62.9	74.3	**70.9**	1.6	3.9	**2.4**	2.4	14.7	1.9	78.3	2.7
1.4	2.0	**1.7**	69.6	73.8	**72.6**	2.1	2.7	**2.3**	2.1	12.8	1.9	80.7	2.5
1.6	2.4	**2.0**	69.3	71.9	**70.3**	1.6	2.3	**1.9**	1.9	14.6	2.2	79.2	2.1
1.6	2.3	**1.7**	70.3	74.8	**72.2**	1.6	2.7	**2.1**	2.0	13.0	1.9	80.8	2.3
1.1	2.4	**1.8**	70.6	75.9	**72.1**	1.3	2.5	**2.0**	1.9	13.0	2.0	80.9	2.2
1.5	2.7	**2.2**	70.0	75.2	**72.3**	1.5	2.4	**2.2**	2.1	12.8	2.3	80.4	2.4
1.6	2.0	**1.8**	68.3	72.2	**70.6**	1.4	1.7	**1.6**	2.3	11.8	2.1	82.1	1.7
0.4	2.9	**1.8**	70.9	76.6	**73.9**	2.0	2.5	**2.3**	1.8	11.5	2.0	82.1	2.6
1.2	1.9	**1.5**	74.5	77.5	**76.3**	1.7	2.3	**2.0**	1.9	9.5	1.7	84.7	2.2
0.9	2.8	**1.7**	67.9	76.1	**72.2**	1.4	2.6	**2.0**	1.8	13.2	1.9	80.9	2.2
1.5	2.9	**2.0**	66.7	74.4	**71.3**	1.7	2.3	**2.1**	2.1	13.9	2.2	79.5	2.3
1.2	2.0	**1.7**	69.6	73.7	**71.9**	1.8	2.6	**2.2**	1.9	13.6	1.8	80.1	2.5
0.4	2.9	**1.8**	66.7	77.7	**72.0**	1.3	3.9	**2.1**	2.0	13.1	2.0	80.6	2.3
0.4	3.1	**1.8**	64.8	78.6	**71.9**	1.3	3.9	**2.1**	2.0	13.3	2.0	80.4	2.3
0.1	0.4	**0.2**	77.5	80.6	**79.2**	0.3	0.6	**0.4**	0.4	8.5	0.2	90.5	0.4
7.8	9.4	**8.7**	62.6	65.4	**64.5**	2.2	2.4	**2.2**	2.3	11.5	9.9	73.7	2.6
2.5	6.1	**4.8**	26.2	32.8	**28.8**	12.3	19.0	**16.9**	5.3	38.1	5.4	32.2	18.9
3.4	5.0	**4.1**	50.5	62.0	**55.7**	1.3	1.6	**1.4**	3.8	24.4	4.8	65.5	1.7
0.5	3.1	**1.9**	60.4	74.0	**68.7**	2.0	5.1	**3.8**	1.6	10.8	2.2	81.0	4.4
4.7	9.4	**6.6**	56.8	69.7	**64.8**	2.5	4.7	**3.5**	1.7	10.0	7.8	76.4	4.1
0.6	1.2	**0.9**	66.6	69.0	**67.4**	6.1	8.8	**7.1**	2.2	15.9	1.0	73.2	7.7
5.0	7.0	**6.5**	63.5	68.0	**66.3**	1.5	3.2	**2.2**	3.0	11.9	7.3	75.3	2.5
0.4	0.5	**0.4**	77.6	79.1	**78.3**	0.8	0.9	**0.8**	0.8	7.7	0.5	90.1	1.0
0.1	1.0	**0.2**	71.5	78.5	**75.0**	0.6	1.8	**1.1**	0.5	12.3	0.2	85.8	1.2
1.8	2.0	**1.9**	69.8	70.0	**69.8**	1.7	1.9	**1.7**	2.0	13.4	2.2	80.4	2.0
0.2	0.5	**0.3**	71.1	79.4	**75.8**	0.7	1.8	**1.4**	1.2	8.0	0.4	88.8	1.6

AVERAGE COMPOSITION OF AMERICAN FEEDING

	Number of analyses.	In fresh or air-dry material.								
		Water.			Ash.			Protein (N×6.25).		
		Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
MILL PRODUCTS—Continued.		%	%	%	%	%	%	%	%	%
Ground linseed	2	7.9	8.3	**8.1**	3.4	6.1	**4.7**	20.3	23.0	**21.6**
Pea meal	2	8.9	12.1	**10.5**	2.6	2.7	**2.6**	19.1	21.4	**20.2**
Ground corn and oats, equal parts	6	10.7	13.1	**11.9**	1.9	2.7	**2.2**	8.4	10.4	**9.6**
BY-PRODUCTS AND WASTE MATERIALS.										
Corn (maize) cob	18	7.2	24.8	**10.7**	0.7	2.7	**1.4**	1.2	3.7	**2.4**
Hominy chops	12	8.1	13.5	**11.1**	1.9	3.1	**2.5**	7.9	11.2	**9.8**
Corn (maize) germ	3	9.4	13.0	**10.7**	1.9	7.4	**4.0**	9.7	9.9	**9.8**
Gluten meal	32	6.4	12.3	**9.6**	0.1	1.7	**0.7**	21.3	35.5	**29.4**
Starch feed, wet	12	62.3	72.2	**65.4**	0.1	0.6	**0.3**	3.6	9.6	**6.1**
Oat feed	4	6.4	9.2	**7.7**	3.2	4.2	**3.7**	12.6	20.0	**16.0**
Barley screenings	2	12.0	12.4	**12.2**	3.5	3.6	**3.6**	12.1	12.5	**12.3**
Malt sprouts	4	7.3	12.0	**10.2**	3.8	6.7	**5.7**	21.0	25.9	**23.2**
Brewers' grains, wet	15	68.6	79.4	**75.7**	0.3	1.5	**1.0**	4.3	6.9	**5.4**
Brewers' grains, dried	3	6.2	11.9	**8.2**	3.3	3.8	**3.6**	19.3	20.3	**19.9**
Rye bran	7	8.2	13.7	**11.6**	2.9	4.5	**3.6**	11.5	16.8	**14.7**
Wheat bran, from spring wheat	10	7.4	13.6	**11.5**	4.0	6.0	**5.4**	14.3	18.1	**16.1**
Wheat bran, from winter wheat	7	10.6	13.6	**12.3**	5.0	6.4	**5.9**	13.9	17.8	**16.0**
Wheat bran, all analyses	88	7.4	15.8	**11.9**	2.5	7.8	**5.8**	12.1	18.9	**15.4**
Wheat middlings	32	9.2	16.0	**12.1**	1.4	6.3	**3.3**	10.1	20.0	**15.6**
Wheat shorts	12	4.1	15.5	**11.8**	2.0	6.2	**4.6**	11.1	19.4	**14.9**
Wheat screenings	10	7.8	13.6	**11.6**	1.9	3.8	**2.9**	8.3	16.9	**12.5**
Wheat screenings meal	2	7.3	12.6	**10.0**	2.9	3.2	**3.1**	6.6	9.0	**7.8**
Wheat flour of screenings	3	12.1	13.3	**12.9**	2.9	3.2	**3.0**	7.3	10.2	**8.9**
Cockle bran	3	10.2	11.8	**11.1**	3.0	3.6	**3.2**	9.4	11.9	**10.6**
Rice bran	5	8.8	10.7	**9.7**	8.4	12.4	**10.0**	10.9	13.6	**12.1**
Rice hulls	3	7.7	8.5	**8.2**	10.5	15.1	**13.2**	2.9	4.7	**3.6**
Rice polish	4	9.0	11.2	**10.0**	2.8	11.3	**6.7**	10.9	12.9	**11.7**
Buckwheat middlings	3	9.5	16.3	**13.2**	4.4	5.5	**4.8**	25.1	31.3	**28.9**
Cotton-seed meal	35	5.8	18.5	**8.2**	5.7	8.8	**7.2**	23.3	50.8	**42.3**
Cotton-seed hulls	4	10.0	11.5	**10.4**	2.3	3.0	**2.6**	3.5	4.8	**4.0**
Linseed meal, old-process	21	5.6	12.4	**9.2**	4.6	8.2	**5.7**	27.7	38.2	**32.9**
Linseed meal, new-process	14	6.0	13.4	**10.1**	5.0	6.9	**5.8**	27.1	38.4	**33.2**
Palm-nut meal	3	6.1	10.8	**8.3**	3.5	4.0	**3.7**	13.5	16.0	**14.4**
Apple pomace	7	69.9	82.5	**76.7**	0.2	0.8	**0.5**	1.0	1.7	**1.4**

STUFFS, WITH MAXIMA AND MINIMA—Continued.

In fresh or air-dry material.									Calculated to water-free substance.				
Crude fiber.			Nitrogen-free extract.			Fat.			Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Average.	Average.	Average.	Average.	Average.
%	%	%	%	%	%	%	%	%	%	%	%	%	%
5.0	9.6	**7.3**	25.5	30.2	**27.9**	30.3	30.5	**30.4**	5.1	23.4	8.1	30.4	33.0
11.1	17.7	**14.4**	50.2	52.0	**51.1**	0.9	1.5	**1.2**	2.9	22.5	16.0	57.2	1.4
......	......	......	70.4*a*	73.7*a*	**71.9*a***	4.0	5.0	**4.4**	2.4	10.9	......	81.7*	5.0
18.2	38.3	**30.1**	43.8	66.7	**54.9**	0.1	0.9	**0.5**	1.6	2.7	33.7	61.4	0.6
2.5	6.7	**3.8**	61.0	71.1	**64.5**	4.5	11.2	**8.3**	2.8	11.0	4.3	72.6	9.3
1.9	5.8	**4.1**	61.9	67.4	**64.0**	5.2	11.2	**7.4**	4.5	11.0	4.6	71.7	8.3
0.3	5.0	**1.6**	47.7	58.5	**52.4**	3.4	9.6	**6.3**	0.8	32.5	1.8	57.9	7.0
1.6	4.4	**3.1**	18.7	28.9	**22.0**	1.3	4.4	**3.1**	0.8	17.7	9.0	63.6	9.1
3.7	12.5	**6.1**	56.2	63.7	**59.4**	6.1	7.8	**7.1**	4.0	17.3	6.6	64.4	7.7
7.0	7.6	**7.3**	61.6	62.0	**61.8**	2.6	2.9	**2.8**	4.0	14.0	8.3	70.4	3.3
9.3	12.0	**10.7**	45.5	50.3	**48.5**	1.1	3.0	**1.7**	6.3	25.8	11.8	54.2	1.9
3.1	5.6	**3.8**	9.6	15.9	**12.5**	0.8	2.9	**1.6**	3.9	22.4	15.7	51.5	6.5
10.2	11.6	**11.0**	46.1	56.8	**51.7**	4.2	6.5	**5.6**	3.9	21.7	12.0	56.3	6.1
2.5	4.1	**3.5**	59.8	67.6	**63.8**	1.8	4.9	**2.8**	4.1	16.6	4.0	72.1	3.2
5.4	10.1	**8.0**	51.7	58.1	**54.5**	3.6	5.0	**4.5**	6.1	18.2	9.0	61.6	5.1
7.2	8.9	**8.1**	50.5	56.2	**53.7**	3.5	4.5	**4.0**	6.7	18.2	9.2	61.3	4.6
2.4	15.5	**9.0**	45.5	63.2	**53.9**	1.5	7.0	**4.0**	6.6	17.4	10.2	61.3	4.5
1.3	12.7	**4.6**	53.0	70.9	**60.4**	2.1	5.9	**4.0**	3.8	17.8	5.2	68.7	4.5
6.0	10.5	**7.4**	50.0	62.3	**56.8**	2.5	6.1	**4.5**	5.2	16.8	8.4	64.5	5.1
1.7	7.5	**4.9**	61.0	70.4	**65.1**	2.7	3.3	**3.0**	3.3	14.1	5.5	73.7	3.4
5.7	6.6	**6.2**	68.2	71.4	**69.8**	2.8	3.8	**3.3**	3.4	8.7	6.9	77.3	3.7
3.8	9.0	**5.5**	62.3	69.9	**66.1**	3.1	4.0	**3.6**	3.4	10.2	6.3	76.0	4.1
7.6	11.0	**9.2**	62.4	64.4	**63.5**	2.1	2.8	**2.5**	3.6	11.9	10.3	71.4	2.8
2.0	17.8	**9.5**	41.9	62.3	**49.9**	5.2	10.9	**8.8**	11.0	13.4	10.4	55.5	9.7
30.3	38.6	**35.7**	36.0	41.6	**38.6**	0.6	0.9	**0.7**	14.4	3.9	38.8	42.2	0.7
2.4	14.5	**6.3**	45.5	63.3	**58.0**	6.5	8.0	**7.3**	7.4	12.9	7.0	64.6	8.1
2.4	5.7	**4.1**	36.3	52.7	**41.9**	5.7	8.1	**7.1**	5.5	33.3	4.6	48.5	8.1
1.3	10.1	**5.6**	15.7	38.7	**23.6**	8.8	18.0	**13.1**	7.8	46.1	6.1	25.8	14.2
35.8	51.4	**44.4**	32.0	41.2	**36.6**	0.8	3.8	**2.0**	2.9	4.5	49.5	40.9	2.2
4.7	13.3	**8.9**	28.4	41.9	**35.4**	5.2	11.6	**7.9**	6.3	36.2	9.7	39.2	8.6
7.6	14.0	**9.5**	35.2	48.0	**38.4**	1.3	4.4	**3.0**	6.5	36.9	10.5	42.8	3.3
18.8	24.0	**21.4**	33.8	41.7	**38.9**	6.4	18.7	**13.3**	4.1	15.7	23.4	43.4	14.5
2.0	5.9	**3.9**	12.6	21.2	**16.2**	0.6	2.0	**1.3**	2.2	5.9	16.6	69.6	5.7

a Including fiber.

TABLE II.

AVERAGE FERTILIZING CONSTITUENTS OF AMERICAN FEEDING STUFFS.

FERTILIZING CONSTITUENTS OF AMERICAN FEEDING STUFFS.

	Moisture.	Ash.	Nitrogen.	Phosphoric acid.	Potassium oxide.
GREEN FODDERS.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn fodder	78.61	4.84	0.41	0.15	0.33
Sorghum fodder	82.19	....	0.23	0.09	0.23
Rye fodder	62.11	....	0.33	0.15	0.73
Oat fodder	83.36	1.31	0.49	0.13	0.38
Common millet	62.58	....	0.61	0.19	0.41
Japanese millet	71.05	....	0.53	0.20	0.34
Hungarian grass (German millet)	74.31	....	0.39	0.16	0.55
Orchard grass (*Dactylis glomerata*) *	73.14	2.09	0.43	0.16	0.76
Timothy grass (*Phleum pratense*) *	66.90	2.15	0.48	0.26	0.76
Perennial rye grass (*Lolium perenne*) *	75.20	2.60	0.47	0.28	1.10
Italian rye grass (*Lolium italicum*) *	74.85	2.84	0.54	0.29	1.14
Mixed pasture grasses	63.12	3.27	0.91	0.23	0.75
Red clover (*Trifolium pratense*)	80.00	....	0.53	0.13	0.46
White clover (*Trifolium repens*)	81.00	....	0.56	0.20	0.24
Alsike clover (*Trifolium hybridum*)	81.80	1.47	0.44	0.11	0.20
Scarlet clover (*Trifolium incarnatum*)	82.50	....	0.43	0.13	0.49
Alfalfa (*Medicago sativa*)	75.30	2.25	0.72	0.13	0.56
Cowpea	78.81	1.47	0.27	0.10	0.31
Serradella (*Ornithopus sativus*)	82.59	1.82	0.41	0.14	0.42
Soja bean (*Glycine soja*)	73.20	....	0.29	0.15	0.53
Horse bean (*Vicia faba*)	74.71	....	0.68	0.33	1.37
White lupine (*Lupinus albus*)	85.35	....	0.44	0.35	1.73
Yellow lupine (*Lupinus luteus*)*	83.15	0.96	0.51	0.11	0.15
Flat pea (*Lathyrus sylvestris*)*	71.60	1.93	1.13	0.18	0.58
Common vetch (*Vicia sativa*)*	84.50	1.94	0.59	1.19	0.70
Prickly comfrey (*Symphytum asperrimum*)	84.36	2.45	0.42	0.11	0.75
Corn silage	77.95	....	0.28	0.11	0.37
Corn and soja bean silage	71.03	....	0.79	0.42	0.44
Apple pomace silage*	75.00	1.05	0.32	0.15	0.40
HAY AND DRY COARSE FODDERS.					
Corn fodder (with ears)	7.85	4.91	1.76	0.54	0.89
Corn stover (without ears)	9.12	3.74	1.04	0.29	1.40
Teosinte (*Euchlæna luxurians*)	6.06	6.53	1.46	0.55	3.70
Common millet	9.75	....	1.28	0.49	1.69
Japanese millet	10.45	5.80	1.11	0.40	1.22
Hungarian grass	7.69	6.18	1.20	0.35	1.30
Hay of mixed grasses	11.99	6.34	1.41	0.27	1.55
Rowen of mixed grasses	18.52	9.57	1.61	0.43	1.49
Redtop (*Agrostis vulgaris*)	7.71	4.59	1.15	0.36	1.02
Timothy	7.52	4.93	1.26	0.53	0.90
Orchard grass	8.84	6.42	1.31	0.41	1.88
Kentucky blue-grass (*Poa pratensis*)	10.35	4.16	1.19	0.40	1.57
Meadow fescue (*Festuca pratensis*)	8.89	8.08	0.99	0.40	2.10
Tall meadow oat grass (*Arrhenatherum avenaceum*)	15.35	4.92	1.16	0.32	1.72
Meadow foxtail (*Alopecurus pratensis*)	15.35	5.24	1.54	0.44	1.99
Perennial rye grass	9.13	6.79	1.23	0.56	1.55
Italian rye grass	8.71	....	1.19	0.56	1.27
Salt marsh hay	5.36	....	1.18	0.25	0.72
Japanese buckwheat	5.72	....	1.63	0.85	3.32
Red clover	11.33	6.93	2.07	0.38	2.20
Mammoth red clover (*Trifolium medium*)	11.41	8.72	2.23	0.55	1.22
White clover	....	....	2.75	0.52	1.81
Scarlet clover*	18.30	7.70	2.05	0.40	1.31
Alsike clover	9.94	11.11	2.34	0.67	2.23
Alfalfa	6.55	7.07	2.19	0.51	1.68
Blue melilot (*Melilotus cœruleus*)	8.22	13.65	1.92	0.54	2.80
Bokhara clover (*Melilotus alba*)	7.43	7.70	1.98	0.56	1.83
Sainfoin (*Onobrychis sativa*)	12.17	7.55	2.63	0.76	2.02
Sulla (*Hedysarum coronarium*)	9.39	....	2.46	0.45	2.09
Lotus villosus	11.52	8.23	2.10	0.59	1.81
Soja bean (whole plant)	6.30	6.47	2.32	0.67	1.08
Soja bean (straw)	13.00	....	1.75	0.40	1.32
Cowpea (whole plant)	10.95	8.40	1.95	0.52	1.47
Serradella	7.39	10.60	2.70	0.78	0.65
Scotch tares	15.80	....	2.96	0.82	3.00
Oxeye daisy (*Chrysanthemum leucanthemum*)	9.65	6.37	0.28	0.44	1.25
Dry carrot tops	9.76	12.52	3.13	0.61	4.88

* Dietrich and König: Zusammensetzung und Verdaulichkeit der Futtermittel.

FERTILIZING CONSTITUENTS OF AMERICAN FEEDING STUFFS—Continued.

	Moisture.	Ash.	Nitrogen.	Phosphoric acid.	Potassium oxide.
HAY AND DRY COARSE FODDERS—Cont'd.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Barley straw	11.44	5.30	1.31	0.30	2.09
Barley chaff	13.08	....	1.01	0.27	0.99
Wheat straw	12.56	3.81	0.59	0.12	0.51
Wheat chaff	8.05	7.18	0.79	0.70	0.42
Rye straw	7.61	3.25	0.46	0.28	0.79
Oat straw	9.09	4.76	0.62	0.20	1.24
Buckwheat hulls	11.90	....	0.49	0.07	0.52
ROOTS, BULBS, TUBERS, ETC.					
Potatoes	79.75	0.99	0.21	0.07	0.29
Red beets	87.73	1.13	0.24	0.09	0.44
Yellow fodder beets	90.60	0.95	0.19	0.09	0.46
Sugar beets	86.95	1.04	0.22	0.10	0.48
Mangel-wurzels	87.29	1.22	0.19	0.09	0.38
Turnips	89.49	1.01	0.18	0.10	0.39
Ruta-bagas	89.13	1.06	0.19	0.12	0.49
Carrots	89.79	9.22	0.15	0.09	0.51
GRAINS AND OTHER SEEDS.					
Corn kernels	10.88	1.53	1.82	0.70	0.40
Sorghum seed	14.00	....	1.48	0.81	0.42
Barley *	14.30	2.48	1.51	0.79	0.48
Oats	18.17	2.98	2.06	0.82	0.62
Wheat (spring)	14.35	1.57	2.36	0.70	0.39
Wheat (winter)	14.75	....	2.36	0.89	0.61
Rye	14.90	....	1.76	0.82	0.54
Common millet	12.68	....	2.04	0.85	0.36
Japanese millet	13.68	....	1.73	0.69	0.38
Rice	12.60	0.82	1.08	0.18	0.09
Buckwheat	14.10	....	1.44	0.44	0.21
Soja beans	18.33	4.99	5.30	1.87	1.99
MILL PRODUCTS.					
Corn meal	12.95	1.41	1.58	0.63	0.40
Corn-and-cob meal	8.96	....	1.41	0.57	0.47
Ground oats	11.17	3.37	1.86	0.77	0.59
Ground barley	13.43	2.06	1.55	0.66	0.34
Rye flour	14.20	....	1.68	0.85	0.65
Wheat flour	9.83	1.22	2.21	0.57	0.54
Pea meal	8.85	2.68	3.08	0.82	0.99
BY-PRODUCTS AND WASTE MATERIALS.					
Corn cobs	12.09	0.82	0.50	0.06	0.60
Hominy feed	8.93	2.21	1.63	0.98	0.49
Gluten meal	8.59	0.73	5.03	0.33	0.05
Starch feed (glucose refuse)	8.10	....	2.62	0.29	0.15
Malt sprouts	10.38	12.48	3.55	1.43	1.63
Brewers' grains (dry)	6.98	6.15	3.05	1.26	1.55
Brewers' grains (wet)	75.01	....	0.89	0.31	0.05
Rye bran	12.50	4.60	2.32	2.28	1.40
Rye middlings*	12.54	3.52	1.84	1.26	0.81
Wheat bran	11.74	6.25	2.67	2.89	1.61
Wheat middlings	9.18	2.30	2.63	0.95	0.63
Rice bran	10.20	12.94	0.71	0.29	0.24
Rice polish	10.30	9.00	1.97	2.67	0.71
Buckwheat middlings *	14.70	1.40	1.38	0.68	0.34
Cotton-seed meal	9.90	6.82	6.64	2.68	1.79
Cotton-seed hulls	10.63	2.61	0.75	0.18	1.08
Linseed meal (old process)	8.88	6.08	5.43	1.66	1.37
Linseed meal (new process)	7.77	5.37	5.78	1.83	1.39
Apple pomace	80.50	0.27	0.23	0.02	0.13

* Dietrich and König.

TABLE III.

COMPOSITION OF VEGETABLES, FRUITS, AND NUTS.

COMPOSITION OF VEGETABLES.

	Food constituents.						Fertilizing constituents.		
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Nitrogen.	Phosphoric acid.	Potash.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Artichokes	81.50	0.99	2.23	0.63	14.54	0.11	0.36	0.17	0.48
Asparagus stems	93.96	0.67	1.83	0.74	2.55	0.25	0.29	0.08	0.29
Beans, adzuki	15.86	3.53	20.57	3.86	55.49	0.69	3.29	0.95	1.51
Beans, Lima	68.46	1.69	7.15	1.71	20.30	0.69	....	....	....
Beans, string	87.23	0.76	2.20	1.92	7.52	0.37	....	....	....
Beets, red	88.47	1.04	1.53	0.88	7.94	0.14	0.24	*0.09	*0.44
Cabbages	90.52	1.40	2.39	1.47	3.85	0.37	0.38	*0.11	*0.43
Carrots	88.59	1.02	1.14	1.27	7.56	0.42	0.16	0.09	0.51
Cauliflower	90.82	0.81	1.62	1.02	4.94	0.79	0.13	0.16	0.36
Chorogi, tubers	78.90	1.09	12.04	....	....	....	1.92	0.19	0.64
Chorogi, whole plant	78.33	1.02	1.50	0.73	18.24	0.18	....	....	....
Cucumbers	95.99	0.46	0.81	0.69	1.83	0.22	0.16	0.12	0.24
Eggplant	92.93	0.50	1.15	0.77	4.34	0.31	....	....	....
Horse-radish, root	76.68	1.87	....	....	....	....	0.36	0.07	1.16
Kohl-rabi	91.08	1.27	2.01	1.27	4.29	0.09	0.48	0.27	0.43
Lettuce, leaves	86.28	1.71	2.27	2.57	6.22	0.95	....	....	....
Lettuce, stems	88.46	1.18	0.88	2.68	6.15	0.65	....	....	....
Lettuce, whole plant	93.68	1.61	1.41	0.74	2.18	0.38	0.23	*0.07	*0.37
Muskmelons, interior juice	92.61	1.01	0.91	....	5.47	....	....	....	....
Muskmelons, pulp	76.44	1.49	1.36	2.13	18.40	0.18	....	....	....
Muskmelons, pulp juice	90.53	0.56	0.50	....	8.41		....	....	....
Muskmelons, rind	91.15	0.68	0.62	0.88	6.17	0.50	....	....	....
Mustard, white	84.19	2.25	4.34	2.04	4.67	0.51	....	....	....
Okra	87.41	0.74	1.99	3.42	6.04	0.40	....	....	....
Onions	87.55	0.57	1.40	0.69	9.53	0.26	0.14	0.04	0.10
Parsnips	80.34	1.03	1.35	0.53	16.09	0.66	0.22	0.19	0.62
Peas, Canada field	12.48	2.36	23.50	2.53	57.69	1.44	....	....	....
Peas, garden	12.62	3.11	27.04	3.90	51.75	1.58	3.58	0.84	1.01
Peas, green	79.93	0.78	3.87	1.63	13.30	0.49	....	....	....
Peas, small (*Lathyrus sativus*), whole plant	5.80	5.94	15.61	30.97	40.38	1.30	2.50	0.59	1.99
Pumpkins, flesh	93.39	0.67	0.91	0.98	3.93	0.12	....	....	....
Pumpkins, rind	86.23	1.36	2.76	3.45	5.71	0.49	....	....	....
Pumpkins, seeds and stringy matter	76.86	1.51	6.00	3.93	4.78	6.92	....	....	....
Pumpkins, whole fruit	92,27	0,63	1.11	1.49	4.34	0,16	*0.11	*0.16	*0.09
Rhubarb, roots	74.35	2.28	....	....	....	....	0.55	0.06	0.53
Rhubarb, stems	92.67	0.94	0.83	1.11	3.26	1.19	....	....	....
Rhubarb, stems and leaves	91.67	1.72	....	....	....	....	0.13	0.02	0.36
Ruta-bagas	88.61	1.15	1.18	1.25	7.66	0.15	0.19	0.12	0.49
Spinach	92.42	1.94	2.10	0.67	2.38	0.49	0.49	0.16	0.27
Squashes, flesh	88.09	1.72	0.92	1.04	8.05	0.18	....	....	....
Squashes, rind	82,00	1.21	2.84	3,19	10.04	0.72	....	....	....
Squashes, seeds and stringy matter	74.03	1.39	5.27	4.26	8.74	6,31	....	....	....
Squashes, whole fruit	94.88	0.41	0.66	0,54	3.23	0.28	....	....	....
Sweet corn, cobs	80.10	0.59	1.33	5.64	11.81	0.53	0.21	0.05	0.22
Sweet corn, husks	86.19	0.56	1.11	3.52	8.40	0.22	0.18	0.07	0.22
Sweet corn, kernels	82.14	0.56	2.88	0.54	12.93	0.95	0.46	0.07	0.24
Sweet corn, stalks	80.86	1.25	1.70	0.44	15.37	0.38	0.28	0.14	0.41
Sweet potatoes, tubers	71.26	1.00	1.42	1.23	24.74	0.35	*0.24	*0.08	*0.37
Sweet potatoes, vines	41.55	5.79	7.66	13.60	29.29	2.11	....	....	....
Tomatoes, fruit†	93.64	0.47	0.91	0.75	3.80	0.43	0.16	0.05	0.27
Tomatoes, roots	73.31	11.72	....	....	....	....	0.24	0.06	0.29
Tomatoes, vines	83.61	3.00	....	....	....	....	0.32	0,07	0.50
Turnips	90.46	0.80	1.14	1.15	6.27	0.18	0.18	0.10	0.39
Watermelons, juice	93.05	0.20	0,12		6.63		....	....	....
Watermelons, pulp	91.87	0.33	0.89	0.55	5.64	0.72	....	....	....
Watermelons, rind	89.97	1.24	1.43	1.41	5.59	0.86	....	....	....
Watermelons, seeds	48.37	1.34	8.01	12.43	26.22	3.63	....	....	....

* Wolff. † Sugar in fruit, 3.05 per cent; acid (malic), 0.40 per cent.

COMPOSITION OF FRUITS AND NUTS.

A. Food and Fertilizing Constituents.

	Food constituents.						Fertilizing constituents.		
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Nitrogen.	Phosphoric acid.	Potash.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Apple leaves, collected in May	72.36	2.33					0.74	0.25	0.25
Apple leaves, collected in September	60.71	3.46					0.89	0.19	0.39
Apples, fruit	85.30	0.39	0.49	1.16	12.01	0.65	0.13	0.01	0.19
Apple trees (young), branches	83.60	0.65						0.04	0.04
Apple trees (young), roots	64.70	1.59						0.11	0.09
Apple trees (young), trunks	51.70	1.17						0.06	0.06
Apple trees (young), whole plant	60.83						0.35	0.05	0.17
Apricots, dried	32.44	1.38	3.27		31.81				
Apricots, fresh	85.16	0.49	1.25				0.19	0.06	0.29
Bananas, flesh	66.25	1.15	1.41	0.96	28.88	1.35			
Blackberries	88.91	0.58	0.94	2.46	5.03	2.08	0.15	0.09	0.20
Blueberries	82.69	0.16	0.88				0.14	0.05	0.05
Cherries, fruit	86.10	0.58	1.10	0.24	11.14	0.84	0.18	*0.06	*0.20
Cherry trees (young), branches	79.50	0.78						0.05	0.06
Cherry trees (young), roots	67.20	1.22						0.08	0.07
Cherry trees (young), trunks	53.20	0.81						0.04	0.06
China berries	16.52	4.13	7.51	23.02	42.21	6.61	1.19	0.43	2.33
Cranberries, fruit	89.59	0.18						0.03	0.09
Cranberries, vines		2.45						0.27	0.32
Currants	86.02	0.53						0.11	0.27
Grapes, fruit, fresh	83.00	0.50					0.16	0.09	0.27
Grapes, fruit, dried and ground†	34.83	1.16	2.94	3.70	56.81	0.56			
Grapes, wood of vine		2.97						0.42	0.67
Lemons	83.83	0.56	0.94	1.09	12.68	0.90	0.15	0.06	0.27
Nectarines	79.00	0.50	0.73				0.12		
Olives, fruit§	58.00	1.42	‡1.12	‡2.26	‡9.48	‡27.62	0.18	0.12	0.86
Olives, leaves§	42.40	2.51					0.91	0.26	0.76
Olives, wood of larger branches§	14.50	0.94					0.88	0.11	0.18
Olives, wood of small branches§	18.75	0.96					0.89	0.12	0.20
Oranges, California	85.21	0.43	1.20				0.19	0.05	0.21
Oranges, Florida	87.71						0.12	0.08	0.48
Peaches, fruit	87.85	0.32						0.05	0.24
Peaches, wood of branches	58.26	1.93					0.90	0.22	0.50
Pears, fruit	83.92	0.54	0.56	2.73	11.46	0.79	0.09	0.03	0.08
Pear trees (young), branches	84.00	0.76						0.04	0.08
Pear trees (young), roots	66.70	1.40						0.07	0.11
Pear trees (young), trunks	49.30	1.71						0.07	0.13
Pineapples	89.28	0.35	0.39	0.41	9.31	0.26			
Plums	47.43	0.54	1.13				0.18	0.02	0.24
Prunes	77.38	0.49	1.01				0.16	0.07	0.31
Raspberries	81.82	0.55	0.99	2.88			0.15	0.48	0.35
Strawberries, fruit	90.84	0.60	0.95	1.43	5.50	0.68	0.15	0.11	0.30
Strawberries, vines		3.34						0.48	0.35
Whortleberries	82.42	0.41	0.66	3.17	10.31	3.03			
Chestnuts, cultivated	40.00	1.78	6.46	1.98	43.20	6.58			
Chestnuts, native	40.00	1.62	7.55	1.78	39.66	9.39	1.18	0.39	0.63
Chestnuts, Spanish	10.00	2.66	9.27	2.43	68.13	7.51			
Peanuts, hulls	10.00	2.99	5.97	65.24	14.07	1.73	1.04	0.14	0.81
Peanuts, kernels	10.00	2.21	26.62	2.41	16.75	42.01	4.01	0.82	0.88
Peanuts, vines after blooming	10.00	12.36	10.01	22.04	42.03	3.56		0.29	0.90
Peanuts, vines before blooming	30.00	7.45	10.59	15.62	32.09	4.25		0.32	1.16

* Wolff

† "Grape food."

‡ In pulp.

§ L. Paparelli: Étude chimique sur l'oliver, Montpellier, 1888.

COMPOSITION OF FRUITS AND NUTS—Continued.

B.—Sugar and Acids in Fruits.

	Per cent.
Apples—	
Baldwin, sugar in juice	10.79
acid (malic) in juice	0.92
Rhode Island Greenings, sugar in juice	11.97
acid (malic) in juice	0.86
Sweet, sugar in juice	11.74
acid (malic) in juice	0.20
Apricots—	
Dried, sugar	29.59
acid (as SO_3)	1.51
Fresh, sugar in whole fruit	11.10
acid (as SO_3) in whole fruit	0.68
Bananas, free acid in fruit	0.41
Blackberries—	
Sugar in fruit	11.50
Acid (malic) in fruit	0.74
Sugar in juice	1.27
Cranberries—	
Sugar in juice	1.52
Acids in juice	2.34
Currants—	
Sugar in juice	1.96
Acid (tartaric) in juice	5.80
Grapes—	
Sugar in juice	10-16
Acid (tartaric) in juice	0.5-1.2
Lemons—	
Sugar in fruit	2.08
Acid (citric) in fruit	7.19
Nectarines—	
Sugar in fruit	14.11
Acid (as SO_3) in fruit	0.62
Oranges—	
Sugar in fruit	9.66
Acid (citric) in fruit	1.34
Peaches—	
Sugar in fruit	17.00
Acid (as SO_3) in fruit	0.24
Pears, sugar in juice	8.93
Pineapples, free acid	0.63
Plums—	
Sugar in fruit	12.89
Acid (as SO_3) in fruit	0.48
Prunes—	
Sugar in fruit	15.35
Acid (as SO_3) in fruit	0.40
Raspberries—	
Sugar in fruit	2.78
Acid (as SO_3) in fruit	0.73
Strawberries—	
Sugar in fruit	5.36
Acid (malic) in fruit	1.37

TABLE IV.

COMPOSITION OF COMMERCIAL FERTILIZING MATERIALS AND FARM MANURES.

COMPOSITION OF COMMERCIAL FERTILIZING MATERIALS.

	Moisture.	Nitrogen.	Potash.	Phosphoric acid. Soluble.	Phosphoric acid. Reverted.	Phosphoric acid. Total.	Lime.	Magnesia.	Sulphuric acid.	Chlorine.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Alga (*Lyngbia majuscula*)	16.26	4.25	0.79			0.19	2.06	1.18		
Ammonite	5.88	11.33				3.43				
Apatite						36.08				
Ashes (anthracite coal)			0.10			0.10				
Ashes (bituminous coal)			0.40			0.40				
Ashes (limekiln)	15.45		1.20			1.14	48.50	2.60		
Ashes (wood, leached)	30.22		1.27			1.51	28.08	2.66	0.14	
Ashes (wood, unleached)	12.50		5.25			1.70	34.00	3.40		
Bat guano	40.09	8.20	1.31	2.37	1.24	3.80				
Bone ash	7.00					35.89	44.89			
Bone black	4.60					28.28				
Bone black (dissolved)				15.40	1.30	17.00				
Bone meal	7.50	4.05		0.40	7.60	23.25				
Bone meal (dissolved)		2.60		13.53		17.60				
Bone meal (free from fat)		6.20				20.10				
Bone meal (from glue factory)		1.70				29.90				
Carnallite			13.68					13.19	0.56	41.56
Caribbean guano	7.31					26.77	39.95	3.29	2.68	
Castor pomace	9.50	5.50	1.10			1.75				
Cotton-hull ashes	7.80		22.75	1.25	6.50	8.85	9.60	10.75		
Cotton-seed meal (decort.)	7.75	7.10	1.80			3.10				
Cotton seed meal (undecort.)		4.30	1.50			3.10				
Cuba guano	24.27	1.67				13.35				
Dried blood	12.50	10.52				1.91				
Dried fish	12.75	7.25		0.55	2.60	8.25				
Eel grass (*Zostera marina*)	81.19	0.35	0.32			0.07	0.51	0.32		
Gas lime	22.28						43.66	8.30	20.73	
Horn and hoof waste	10.17	13.25				1.83				
Kainit	3.20		13.54				1.15	9.80	20.25	33.25
Kelp (*Laminaria saccharina* and *L. digitata*)	87.75	0.20	0.24			0.06	0.40	0.20		
Kieserite	22.70						2.82	17.30	36.10	
Krugite	4.82		8.42				12.45	8.79	31 94	6.63
Lobster shells	7.27	4.50				3.52	22.24	1.30		
Marls (Kentucky)	1.50		0.1–3			0–0.4	3–34			
Marls (Maryland and Virginia)	1.50		0.2–5			0–2	0–40			
Marls (New Jersey greensand)	1.50		3.5–7			1–4	1–9			
Marls (North Carolina)	1.50		0.2–1.5			0–0.4	5–45			
Meat scrap	12.09	10.44				2.07				
Mona Island guano	13.32	0.76			7.55	21.88	37.49			
Muck	50.00	1.10	0.15			0.10				
Mud (salt)	60.00	0.40	0.35			0.10	0.90	0.30	0.50	0.60
Muriate of potash	2.00		51.48							48.80
Navassa phosphate	7.60					34.27	37.45			
Nitrate of potash	1.93	13.09	45.19							
Nitrate of soda	1.40	15.70								
Oleomargarine refuse	8.54	12.12				0.88				
Oyster-shell lime*	15.00		0.05			0.18	55.00	0.35	0.60	
Peat	61.50	0.85	0.18			0.08				
Peruvian guano	14.81	7.35	2.65	3.20	4.10	15.30				
Phosphates from Florida	2.25					24.50	28.50			
Plaster (pure)†							20.93		46.51	
Rockweed (*Fucus nodosus and F. vesiculosus*)	76.90	0.31	0.65			0.10	0.47	0.33		
Seaweed ashes	1.47		0.92			0.30	6.06	4.37	2.98	6.60
Seaweed (mixed)	81.50	0.73	1.50			0.18	0.23	0.18	0.84	0.96
Sewage sludge (precipitated)	88.49	0.05	0.05			0.10	1.58	0.39		
Soot	5.54		1.83							
South Carolina rock (dissolved)				11.60		15.20				

* 18.5 carbonate.

† Nova Scotia plaster contains 94 per cent pure gypsum and 4 per cent carbonate of lime; Onondaga and Cayuga, 65–75 per cent gypsum and 18–28 per cent of carbonate of lime.

COMPOSITION OF COMMERCIAL FERTILIZING MATERIALS—Continued.

	Moisture.	Nitrogen.	Potash.	Phosphoric acid.			Lime.	Magnesia.	Sulphuric acid.	Chlorine.
				Soluble.	Reverted.	Total.				
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
South Carolina rock (ground)	1.50	......	......	0.27	0.07	28.03	41.87	3.03	......	......
Spent tanbark ashes	3.61	......	2.04	......	......	1.61	33.46	3.55	......	......
Sumac waste	63.06	1.19	3.25	......	......	......	1.14	3.25	......	......
Sulphate of ammonia	1.00	20.50	......	......	......	......	......	......	60.00	......
Sulphate of potash and magnesia	4.75	......	25.50	......	......	......	2.57	......	44.25	2.60
Sulphate of potash (high grade)	2.54	......	33.40	......	......	......	......	......	45.72	......
Sylvinite	7.25	......	16.65	......	......	......	......	......	......	......
Tankage	10.00	6.70	......	0.30	5.10	11.80	......	......	......	......
Thomas slag	1.45	......	......	0.00	3.06	23.49	48.66	3.42	......	......
Tobacco stalks	6.18	3.71	5.02	......	......	0.65	2.22	0.59	......	......
Tobacco stems	10.00	2.35	8.20	......	......	0.70	4.20	0.80	0.65	0.65
Wool washings	......	......	3.92	......	......	......	......	......	......	......
Wool waste	15.80	6.50	*1.20	......	......	0.35	0.11	0.06	......	......

COMPOSITION OF FARM MANURES.

Cattle excrement (solid, fresh)	......	0.29	0.10	......	......	0.17	......	......	......	......
Cattle urine (fresh)	......	0.58	0.49	......	......	......	......	......	......	......
Hen manure (fresh)	60.00	1.10	0.56	......	......	0.85	......	......	......	......
Horse excrement (solid)	......	0.44	0.35	......	......	0.17	......	......	......	......
Horse urine (fresh)	......	1.55	1.50	......	......	......	......	......	......	......
Human excrement (solid)	77.20	1.00	0.25	......	......	1.09	......	......	......	......
Human urine	95.90	0.60	0.20	......	......	0.17	......	......	......	......
Pigeon manure (dry)	10.00	3.20	1.00	......	......	1.90	2.10	0.80	0.60	0.50
Poudrette (night soil)	50.00	0.80	0.30	......	......	1.40	0.80	0.60	0.40	0.08
Sheep excrement (solid, fresh)	......	0.55	0.15	......	......	0.31	......	......	......	......
Sheep urine (fresh)	......	1.95	2.26	......	......	0.01	......	......	......	......
Stable manure (mixed)	73.27	0.50	0.60	......	......	0.30	......	......	......	......
Swine excrement (solid, fresh)	......	0.60	0.13	......	......	0.41	......	......	......	......
Swine urine (fresh)	......	0.43	0.83	......	......	0.07	......	......	......	......
Barnyard manure (average)	68.87	0.49	0.43	......	......	0.32	......	......	......	......

* Sometimes as high as 5 per cent.

TABLE V.

ASH CONSTITUENTS OF DIFFERENT WOODS.

ASH CONSTITUENTS OF DIFFERENT WOODS.

	Air-dry wood contains—				The ash contains—			
	Water.	Ash.	Phosphoric acid.	Potash.	Phosphoric acid.	Potash.	Lime.	Magnesia.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ash, wood	10.00	0.32	0.012	0.149	3.58	46.04	23.57	0.60
Chestnut, bark	10.00	3.51	0.114	0.278	3.25	7.93	47.02	0.01
Chestnut, wood	10.00	0 16	0.011	0.029	6.76	18.10	49.18	2.11
Dogwood, bark	10.00	9.87	0.140	0.341	1.42	3.46	49.20	1.40
Dogwood, wood	10.00	0.68	0.057	0.190	8.51	28.04	38.93	6.80
Hickory, bark	10.00	3.97	0.061	0.141	1.54	3.56	46.82	2.59
Hickory, wood	10.00	0.48	0.058	0.138	11.97	28.60	37.94	10.04
Magnolia, bark	10.00	2.98	0.095	0.192	5.31	11.87	23.64	4.89
Magnolia, wood	10.00	0.36	0.032	0.071	8.75	19.54	38.94	8.05
Maple, bark	10.00	9.49	0.421	1.197	4.44	12.61	37.91	3.25
Oak leaves, mixed	....	4.70	....	....	3.35	3.74	29.03	....
Oak post, bark	10.00	12.10	0.116	0.249	0.96	2.06	52.04	0.65
Oak post, wood	10.00	0.77	0.070	0.169	9.00	21.92	46.39	6.88
Oak, red, bark	10.00	6.29	0.103	0.179	1.63	2.84	50.51	1.81
Oak, red, wood	10.00	0.57	0.060	0.140	10.55	24.66	48.26	5.38
Oak, white, bark	10.00	5.95	0.074	0.125	1.24	2.10	52.73	1.62
Oak, white, wood	10.00	0.26	0.025	0.106	9.48	42.16	29.85	3.43
Pine, burr	....	1.09	....	....	3.31	6.92	10.30	....
Pine, Georgia, bark	10.00	0.37	0.013	0.024	1.99	3.56	34.14	2.45
Pine, Georgia, wood	10.00	0.33	0.012	0.050	3.82	15.35	55.24	6.25
Pine, old field, bark	10.00	1.94	0.095	0.077	4.88	3.96	27.95	3.10
Pine, old field, wood	10.00	0.18	0.007	0.008	4.11	3.85	67.73	6.54
Pine, straw, mixed	....	1.65	....	....	4.28	2.08	14.47	....
Pine, yellow, wood	10.00	0.23	0.010	0.045	4.18	19.70	65.53	3.20
Pine, black, wood	10.00	0.21	0.009	0.030	4.33	14.30	58.98	0.50
Sycamore, wood	10.00	0.99	0.121	0.230	12.23	23.17	31.62	0.62